NOVEMBER 1956

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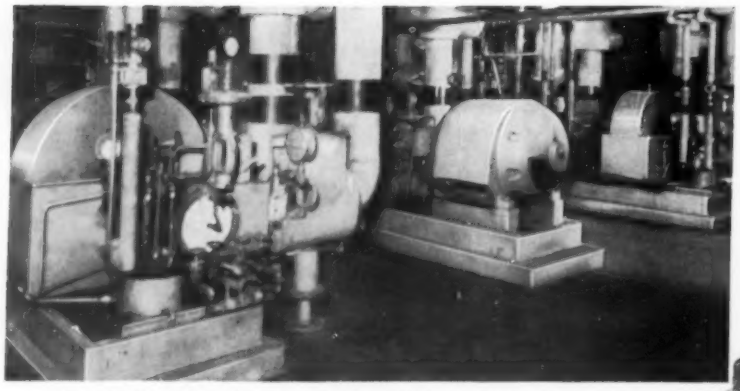
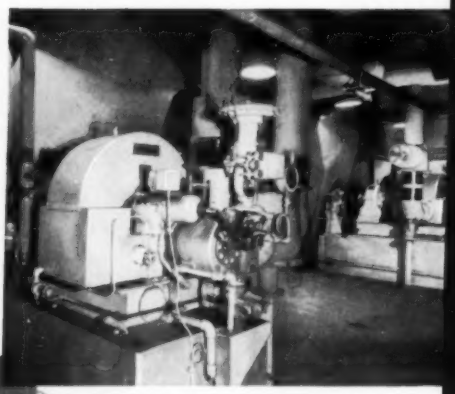
Steam or Electric

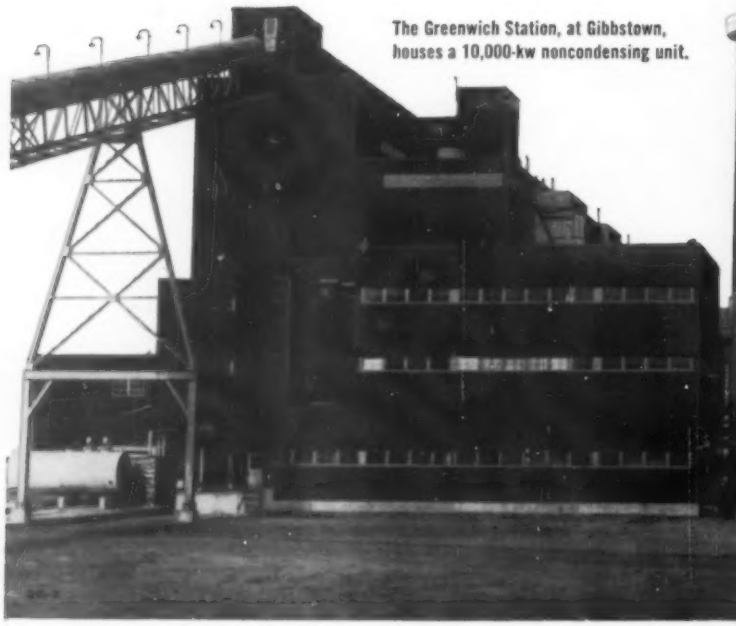
Two Atlantic City Electric Company stations show contrasting use with Elliott Turbines and Motors



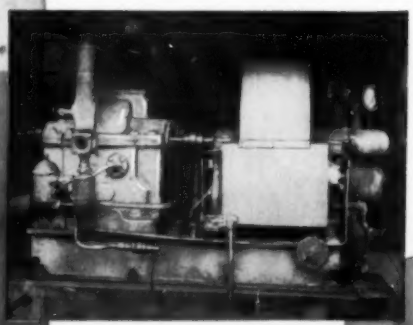
Two Elliott 406-hp, 3550-rpm turbines driving boiler-feed pumps in the Greenwich Station. Turbines take steam at 175 psig, 570 F, and exhaust at 35-psig back pressure. Turbines are suitable for future 700 F operation.



Two Elliott 203-hp, geared turbines driving forced-draft fans at Greenwich Station. Turbines operate at 3570 rpm, which speed is reduced to 1250 rpm on the fans.



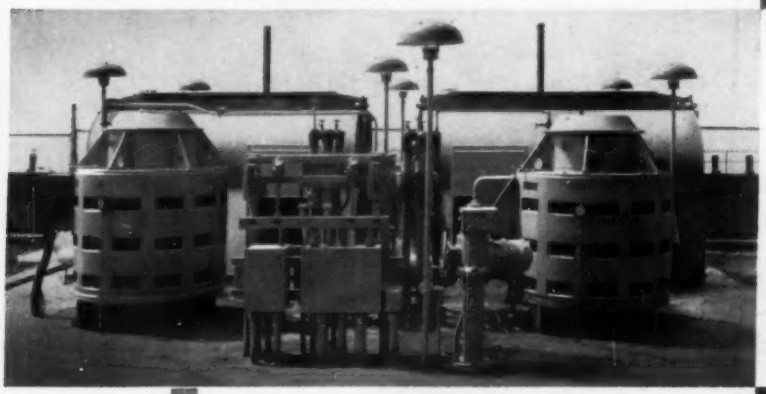
The Greenwich Station, at Gibbstown, houses a 10,000-kw noncondensing unit.



One of two Elliott 450-hp, 3570-rpm turbines driving induced-draft fans at Greenwich Station. Gears reduce speed to 850 rpm. Turbines exhaust at 35 psig.

driven auxiliaries?

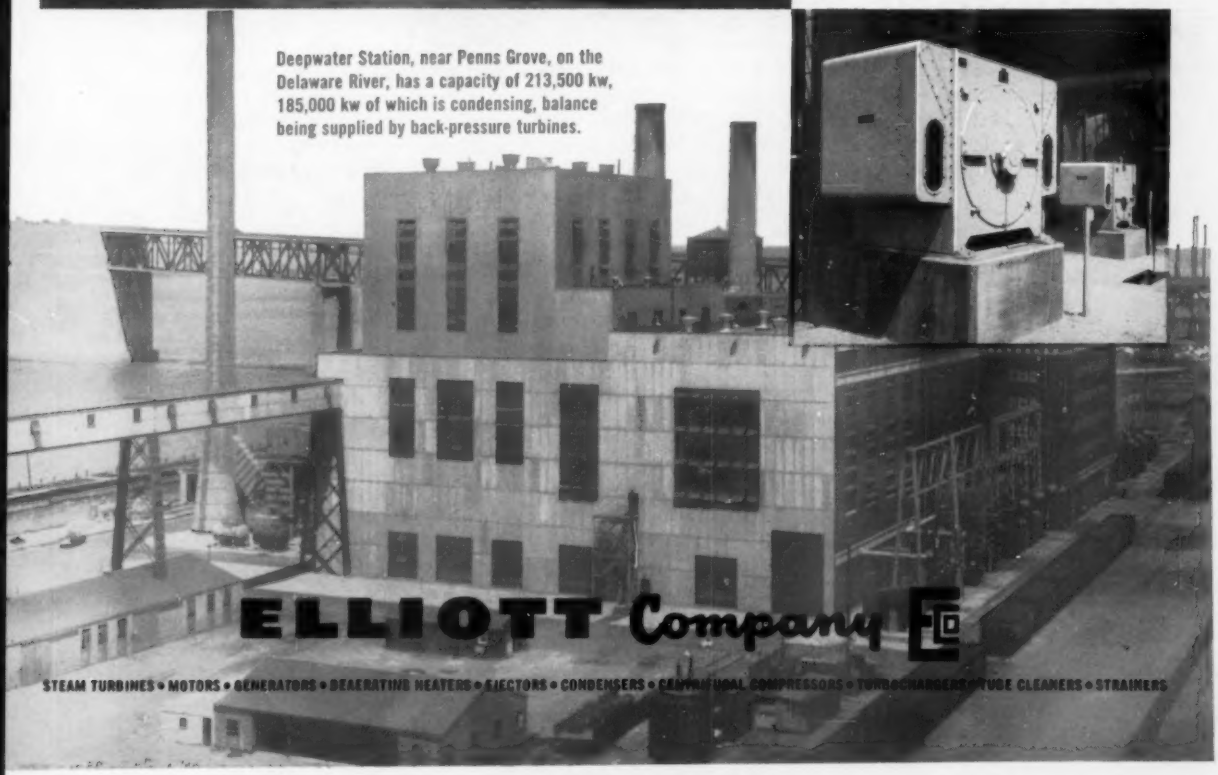
● Both the Greenwich Station at Gibbstown, N. J., and the Deepwater Station near Penns Grove, N. J., furnish process steam for industrial use. The Greenwich Station operates a 10,000 kw, 175 psig back-pressure noncondensing unit and so makes use of steam auxiliary drives. The Deepwater Station, however, houses about 185,000 kw of capacity in condensing units in addition to back-pressure turbines for industrial steam supply. Hence it uses the conventional electric motor drive for auxiliaries. In both cases, Elliott machines — mechanical drive turbines and electric motors — are on the job driving boiler-feed pumps, condensate pumps, forced-draft and induced-draft fans. For details, write Elliott Company, Jeannette, Pa.



Above are three Elliott 900-hp, 3600-rpm squirrel-cage induction motors driving boiler-feed pumps in the Deepwater Station.

At left are two Elliott 300-hp, 514-rpm vertical outdoor weather-protected motors driving circulating pumps at Deepwater.

Below are outdoor weather-protected motors driving draft fans at Deepwater. In foreground is a 1500-hp, 720-rpm motor driving an i-d fan. The other, a 500-hp, 1200-rpm motor, drives an f-d fan.



Deepwater Station, near Penns Grove, on the Delaware River, has a capacity of 213,500 kw, 185,000 kw of which is condensing, balance being supplied by back-pressure turbines.

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DEARBORN 2-5446

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Change of Address: Send to POWER ENGINEERING, Circulation Division, Barrington, Illinois. Please supply your position title, company name, company address. Request must reach us by 15th of month to make the change, effective with the following month's issue.

Subscription Information: Published monthly; price in U. S. and possessions $10 per year; in Canada $11 per year; other countries $12 per year; single copies $1.

Indexed in the Industrial Arts Index and the Engineering Index on file in public and many private libraries.

Microfilm edition: Reques. prices from University Microfilms, Inc. Ann Arbor, Mich. All volumes since 1948

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NBP BPA

PUBLISHED SINCE 1896 FOR POWER ENGINEERS IN PRIVATE AND PUBLIC UTILITIES AND INDUSTRIAL PLANTS

ENGINEERS' PREVIEW

RADICALLY NEW SYSTEM for load surveying developed by the Westinghouse Electric Corp transfers survey data from a recorder installed at the customer's service to punched cards without any need for human interpretation and its risk of error. This includes a compact recorder that transcribes load and time quantities as impulses on magnetic tape, a translator that interprets these impulses as demand values, and a summary punching machine such as IBM's No. 526, which transcribes demand values to standard cards.

Current forecasts indicate average residential loads are to double within the next ten years. As use of electric heating, air conditioning, and other domestic electrical equipment increases, utilities require more timely and accurate data to foresee the effect on system load curves. The Westinghouse load survey system is intended to furnish this data.

ENGINEERS and other non-professional writers will learn the "tricks of the trade" of professional writers and editors in a unique technical writing course to begin October 2, at the Western Technical Writing Institute in Pasadena, Calif.

According to the Institute's director of instruction, Faith Kildare, this is the first writing course that approaches the problem of teaching engineers how to write by showing them what the professional writer does to get good writing.

RESULTS OF a two-year research study by Southwest Research Institute at San Antonio's International Airport may give an economical answer to repair of warping and cracking runways which were not built to withstand today's heavy aircraft loadings. San Antonio Airport taxiways and runways are breaking up and conventional runways strong enough to withstand the load would require concrete twice as thick as the present ones.

Southwest Research Institute scientists tested out both the conventional thick concrete overlays and a thin (four inch) prestressed concrete slab overlayed on existing pavements. The tests were made on Taxiway No. 1, which gets the hardest wear at the airport.

Although the prestressed overlays cost somewhat more at first, it is believed that the greatly increased service life of the pavement and the lowered maintenance cost will more than offset the higher installation expense.

SHEIKHDOM OF KUWAIT, which now operates the world's largest seawater evaporator plant, will soon double the production of drinking water for its capital city, the municipality of Kuwait.

Two new flash-type Westinghouse water evaporators, each capable of producing 1,260,000 U. S. gallons of fresh water a day, will be installed at Shuwaikh, a suburb of the capital. With the addition of the two evaporating units, the Kuwait municipality will be able to produce a minimum of nearly 5,000,000 gallons of fresh water a day by the middle of 1957.

NEW $58,000,000 electric power plant, to house the world's largest generating unit, will be built by the Indiana & Michigan Electric Co. on the Wabash River south of Terre Haute, Ind. It will be served by a new coal mine to be developed nearby by Ayrshire Collieries Corp., of Indianapolis. The mine and power station will be connected by a private 6-mile railroad to be built, owned and operated by Ayrshire. It is estimated that the cost of the new mine and railroad will be in excess of $4,000,000.

The generating unit, which also will be designed as the most efficient power producer in the world, will have a generating capacity of 450,000 kw — 73 per cent larger than any unit operating today. It is the first of two planned on the seven-

state American Gas and Electric Company System, of which I. & M. is a major part. Location of the second unit elsewhere on the AGE System is still under study and is expected to be announced later in the year.

Construction of the power plant will be started in the very near future and that completion is scheduled for late in 1958. Provision has been made in its design for eventual expansion to 900,000 kw. The plant will be tied in to the I. & M. system via a new 330,000-v transmission line.

DO YOU PRACTICE stack twanging? This interesting procedure has been used by the Detroit Edison Co as narrated in a recent issue of *Coal to Kilowatts* in an unusual type of test on stacks at their River Rouge plant. The purpose of the test is to determine the amount of internal dampening in the stacks and their supporting structure. In the case of tall stacks, various forces produced by the wind can vibrate or sway the stacks. So by putting a cable across between two stacks, installing proper instruments near the base of the stack — then pulling the cable down and suddenly releasing it — the stack goes "twang" and the vibrations can be recorded. Details and pictures are given in an interesting article by Jack Smith in the June, 1956 issue of *Coal to Kilowatts*.

SENTENCE-FOR-SENTENCE machine translation of language, now being studied at Massachusetts Institute of Technology, promises translation of higher quality than word-for-word translation, but it will require a great deal of effort to work out the linguistic details, it was recently reported. Sentence-for-sentence translation is under study at the M.I.T. Research Laboratory of Electronics, Victor H. Yngve, of M.I.T., reported to a symposium on communication theory during the Fall General Meeting of the American Institute of Electrical Engineers in the Morrison Hotel, Chicago.

Mr. Yngve summed up the state of the art of mechanical translation as follows: Word-for-word translations can be made now on high-speed, general-purpose, digital computers, and could be made more economically by means of special-purpose machines built with existing technology.

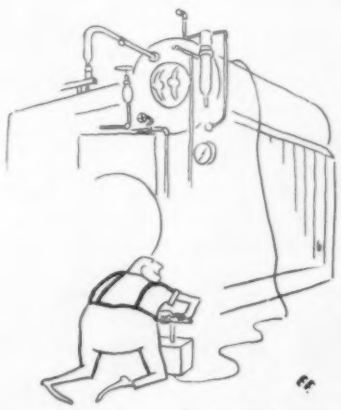
Word-for-word translations promise to be considerably cheaper than man-made translations, and though very crude may be useful when more accurate translations are not worth the additional cost.

A RECENT General Electric publication entitled The Capacitor Digest contains two articles from POWER ENGINEERING and one from our companion magazine *Plant Engineering*. The POWER ENGINEERING articles are Why Capacitors? by Editor A. W. Kramer, and How a Capacitor Works, by Associate Editor R. C. Hagenmiller while the *Plant Engineering* article is condensed from one by T. H. McGreer, entitled Maytag's Capacitors Cut Voltage Dips.

S. MORGAN SMITH Co of York, Penna., announces the receipt of a contract for 5 hydraulic turbine units valued in excess of $3,250,000. Bechtel Corp, engineers and agent for Pacific Power and Light Co and Cowlitz County Public Utility District, placed the order for the Smith-Francis turbines which will be part of two new plants located 3 miles apart on a tributary of the Lewis River in Washington.

Three 100,000 hp units for Swift Creek Plant No. 1 will operate at 180 rpm under a net head of 350 ft. The contract calls for 11 ft diam spiral cases fabricated of T-1 steel for these 3 units. These cases will be sectionalized for field welding of radial splits. The York firm will also design and manufacture three 13 ft hydraulically operated butterfly valves for turbine inlet service at Swift Creek No. 1.

The downstream Swift Creek Plant No. 2 will have 46,000 hp units operating at 128.6 rpm under a 128 ft head. The mild steel spiral cases for this plant measure 16 ft and will be completely field welded. These units will discharge into the forebay of the Yale Development of Pacific Power and Light Co, where 2 70,000 hp SMS turbines, built several years ago, operate under a net effective head of 224 ft.



Courtesy, The Locomotive

Only approved methods should be used to remove scale.

NEW CODE for the Installation and Operation of Pulverized-Coal Systems, NFPA No. 60A, has just been published by the National Fire Protection Association, it is announced.

This new Code is a revision of the 1956 edition and incorporates new material to bring references to equipment and operating practices up-to-date. It covers building construction and equipment, installation of pulverized-coal systems, lighting and operating pulverized-fuel systems and fire prevention and fire protection precautions.

NFPA No. 60A was developed by a representative technical committee under the Chairmanship of Hylton R. Brown, U. S. Bureau of Mines, Washington, D. C.

This pamphlet is available from the National Fire Protection Association, 60 Batterymarch Street, Boston 10, Mass., at 35 cents per copy; it is a 32-page booklet, 4¾ by 7¼ in. in size.

PUBLIC SERVICE Electric and Gas Co, Newark, N. J., has placed an order for the purchase of a new 300,000 kw (400,000 hp) turbine generator unit from G-E. The company plans to install this unit on its system in 1960.

The new turbine generator will consist of two 3600-rpm shafts, each having identical generators. The steam conditions and the location in which the unit will be installed have not been determined. Since 1945 the company has purchased 12 turbine generators, with a total capacity of 2,380,000 kw, for addition to its generating system.

DE LAVAL
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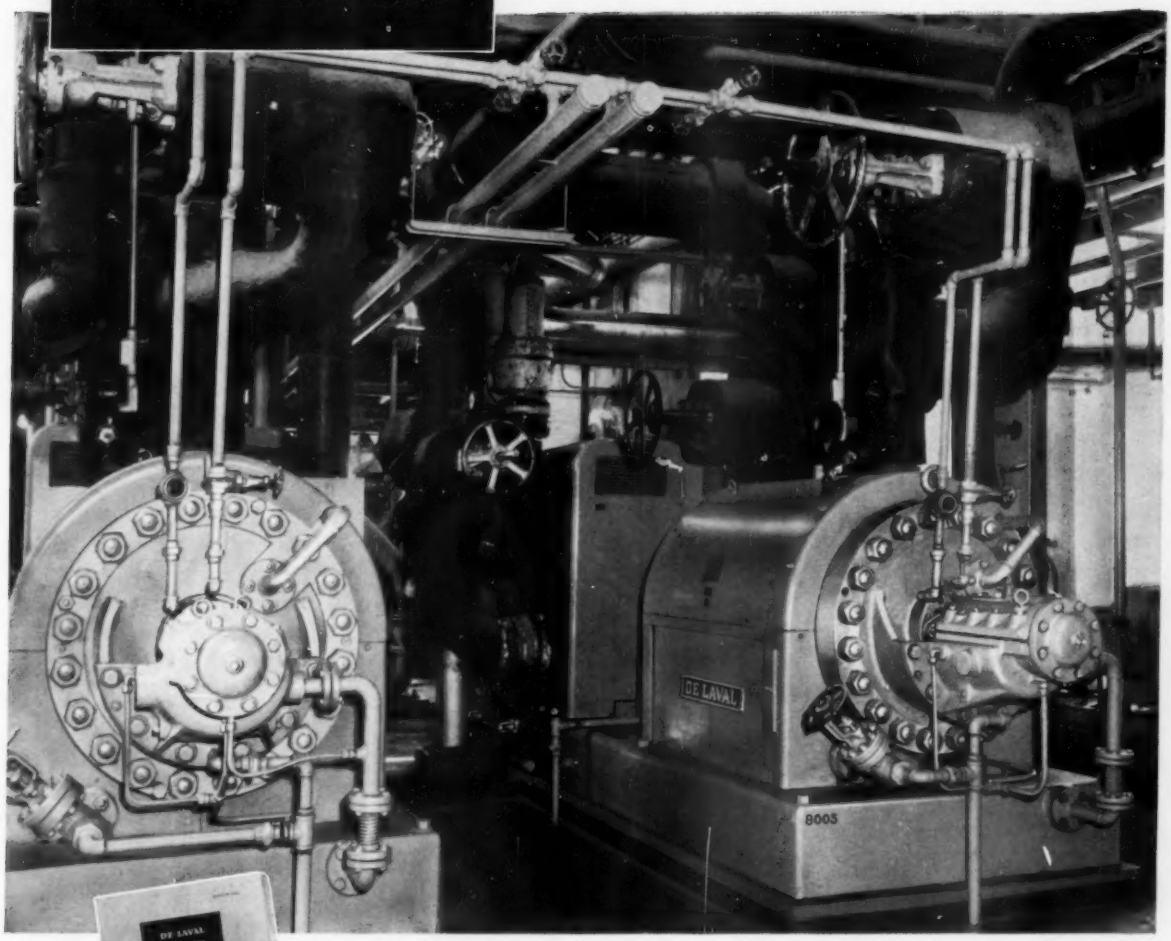
give dependable service at Gaylord Container



Bulletin contains helpful data

Bulletin 1506 on the De Laval barrel type boiler feed pump covers all major design points... has cross-section cutaway illustration for easy reference. Write for your copy.

Here's additional proof of De Laval reliability on the line in the Bogalusa, La. plant of the Gaylord Container Corporation. These two De Laval barrel type boiler feed pumps are both driven by De Laval MCP turbines operating at 850 psi, with steam temperature at 825 F.

• De Laval barrel type boiler feed pumps are widely used by industrial plants and public utilities. They operate at pressures up to 5,500 psi. These units offer many important design advantages, such as double volute diaphragm, individual diaphragm bolting. positive sealing between suction and discharge chamber and bare shaft construction. Their dependability is proven by year-in, year-out service.

DE LAVAL *Boiler Feed Pumps*

DE LAVAL STEAM TURBINE COMPANY

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WHAT THEY TELL US

» CHEF DE SERVICE, P. Vanherk, Union Des Centrales Electriques in Liege, Belgium, recently sent this pertinent comment on indoor and outdoor power plants:

> The April 1956 issue of POWER ENGINEERING brought up a most interesting article by Joseph B. Johnson concerning the relative merits of outdoor and indoor power plants. He is to be highly commended for having given us an objective and impartial view on this important problem.
>
> I should like to mention here one case in point to substantiate Mr. Johnson's view about the vagaries of the weather, and perhaps it may interest some of your readers:
>
> Our indoor power plant has two 3-cylinder, 50-mw, 1000-psi, 950-F, 3000-rpm steam electric generators. One day last winter, unit No. 1 started a slight vibration. This was the more remarkable because it had always been smooth running.
>
> Although the vibration was far from being alarming, it set everybody running and checking. After two days it disappeared without any apparent cause of the trouble being disclosed.
>
> Some time later the same phenomenon occurred; vibrations came and went for no apparent reason. On the next long weekend the turbine was opened, thoroughly checked and found to be satisfactory. The unit was put back into service and was still slightly vibrating.
>
> After further investigation it was felt that the weather might somehow have something to do with it since each period of trouble could be associated with very cold weather.
>
> Checking further again on that idea, we found that a low window just opposite the high-pressure cylinder of unit No. 1 was normally kept open. This induced a draft of cold air to hit the lower part of the cylinder, just on one side, thus causing an uneven cooling and a slight distortion of the whole cylinder. Then the window was closed, and that was the end of our trouble.
>
> Thus it is quite conceivable that in an outdoor installation, a cold wind blowing on one side of the turbine, or a strong summer sun heating the top of it, might cause similar or more serious trouble.
>
> May I add to this a word of congratulation to the staff of POWER ENGINEERING who so successfully strive to maintain, year after year, its high standard and reputation.

» IN A LETTER to Executive Editor Earle, Vice-President G. V. Williamson, Union Electric Company of Missouri, added the following note:

> I find your magazine increasingly interesting and think you are doing a good job.

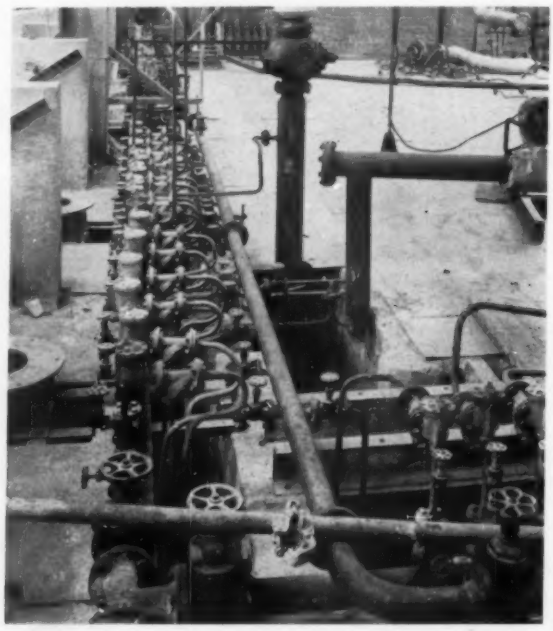
» BENT PIPE, OR FITTINGS? Reader M. G. W. of Chicago, recently acquired the accompanying fine photographs from England and sent them to us with the following comment and question:

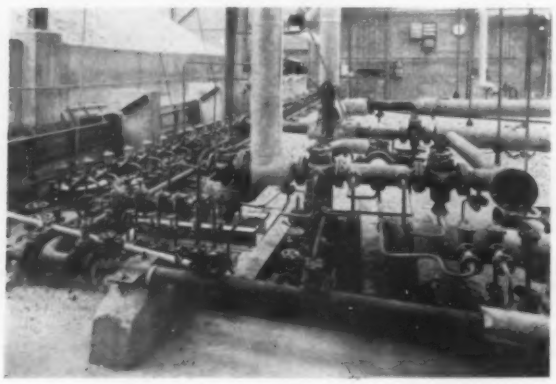
> These pictures show an installation of Drayton-Armstrong traps draining steam coils in sulfur pits at the plant of Messrs. Courtauld, a rayon manufacturer in Manchester, England. The traps are connected by bent pipe and flanges. *See pictures.*
>
> In my observation, a similar installation in the United States would, in most cases, be connected by pieces of straight pipe, with fittings such as elbows, unions, etc. Now that makes me wonder about three things: —
>
> (a) — Is there any particular operating advantage or installation advantage in the use of the bent pipe, as contrasted with pipe and fittings?
>
> (b) — Did they use the bent pipe in this English installation because it was cheaper to install and maintain?
>
> (c) — What would be the relative cost in the United States in using bent pipe as compared with using pipe and fittings?

We suspect that these questions have some resemblance to the famous question "How long should a man's legs be?", asked of Abraham Lincoln, or "How long should an article be?", frequently asked of us. Nevertheless, many power engineers must have some specific data or some profound convictions on which to base an answer to this question. If so, we'd like to hear them and publish them. Write *What They Tell Us*, POWER ENGINEERING, 110 S. Dearborn St., Chicago 3, Ill.

Right: Close-up of installation showing the bent pipe connections

Below: Traps draining steam coils, described by reader





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VALVES

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Instant . . . accurate . . . brilliant . . . continuous readings of boiler water level are seen on the panel or wherever you wish in your plant. You know the readings are right because they are controlled by the boiler water itself . . . by the pressure differential between a constant head of water and the varying head in the boiler drum. *Indicating mechanism is never under pressure.*

Yarway Indicators may be equipped with a Yarway Control Unit that operates Remote Hi-Lo-Alarm signal lights or horns. For a 24-hour record of boiler water levels, use the Yarway Hi-Lo-Graph Recorder.

On the boiler drum itself you'll want Yarway Water Gages . . . and these "bright as a star" gage readings can now be televised with a Yarway—RCA Television chain.

From drum to panel and at all remote locations, Yarway equipment gives you the safest boiler protection you can buy . . . proved beyond doubt in thousands of power plants.

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Clear, brilliant readings from any angle, are possible with the "wide vision" face on the Yarway Remote Liquid Level Indicator. Pointer is always visible, even at extreme high and low water levels.

The Yarway Indicator is manometric type with automatic temperature compensation, as approved for use under the ruling of A.S.M.E. Boiler Code Committee in Case #1155.

Described in Yarway Bulletin WG-1824.

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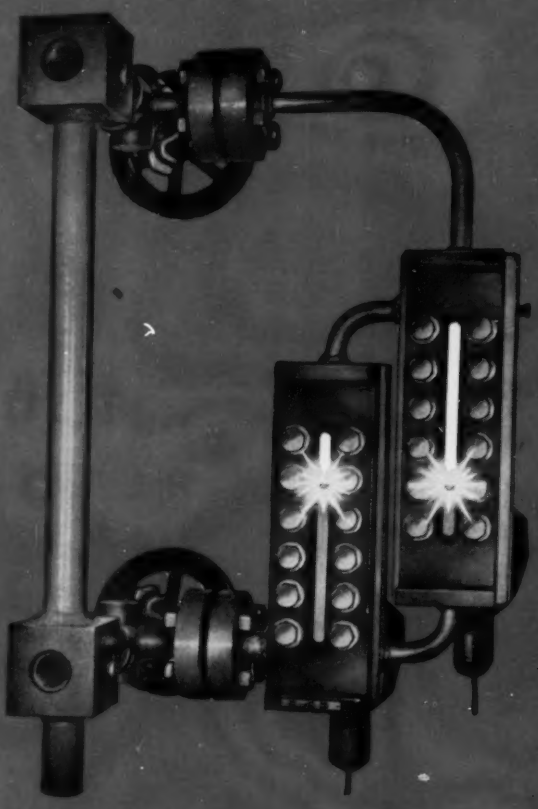
good boiler insurance!"



YARWAY WATER GAGES

Flat glass, high pressure type shown, features new separated-design insert and Type "M" illumination that causes water level meniscus to "shine like a star". Described in Yarway Bulletin WG-1812.

YARWAY REMOTE SIGNAL ALARMS

Lights on horns, operated by Control Unit on Yarway Indicator, give instant warning of any serious deviation from normal water level. Can be located anywhere in plant. Described in Yarway Bulletin WG-1824.

YARWAY HI-LO-GRAPH RECORDER

Gives a continuous 24-hour record of liquid levels. Actuating mechanism is same as in Yarway Indicator. Used both for indicating and recording. Described in Yarway Bulletin WG-1830.

YARWAY RCA TELEVISION

Simplified system consists of compact camera and panel-mounted monitor. Clear, bright image of water level gage anywhere in the plant.
Described in Yarway Bulletin WG-1813.

steam plant equipment

BLOW-OFF VALVES
WATER COLUMNS AND GAGES
LIQUID LEVEL INDICATORS
EXPANSION JOINTS
STEAM TRAPS
STRAINERS
SPRAY NOZZLES
DIGESTER VALVES

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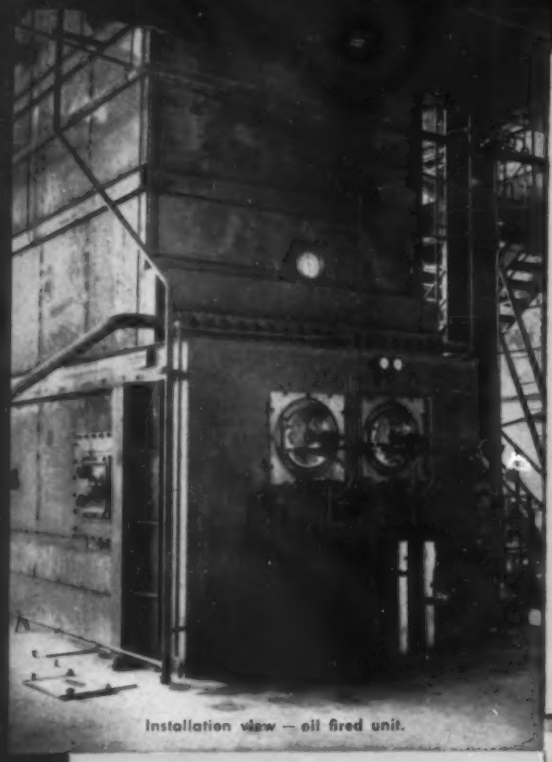
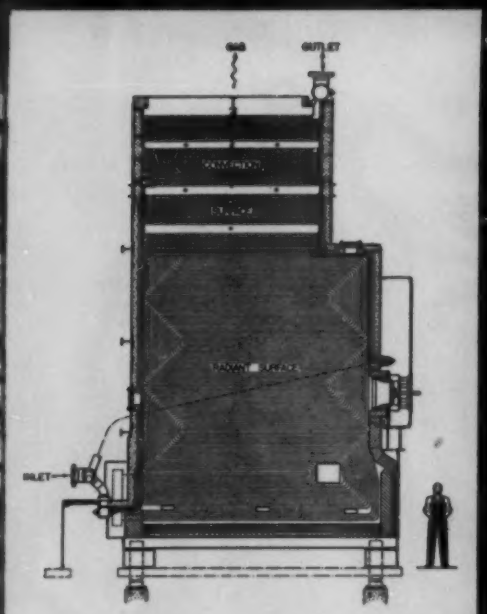
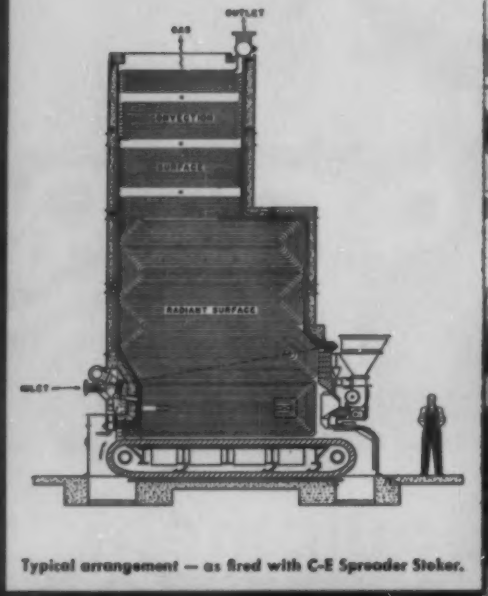
C-E LaMont Controlled Circulation Hot Water Boilers



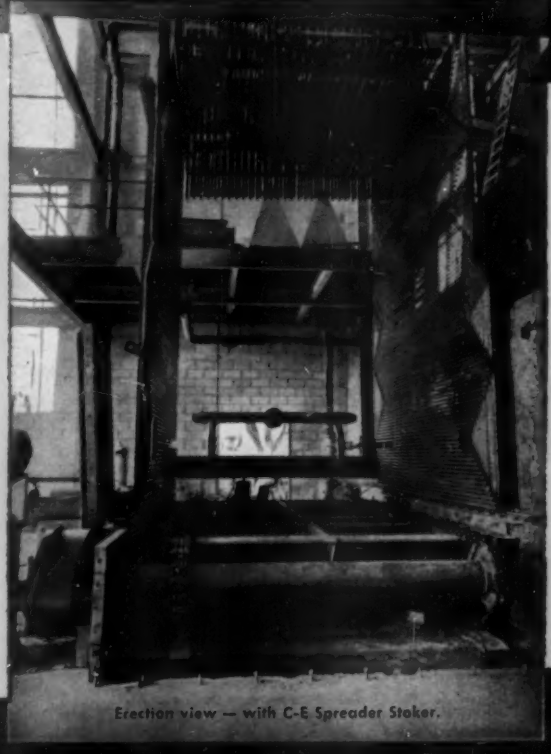
Installation view — oil fired unit.



Typical arrangement — as fired with oil or gas.



Typical arrangement — as fired with C-E Spreader Stoker.



Erection view — with C-E Spreader Stoker.

How about **HIGH TEMPERATURE WATER** *for your heating or processing needs?*

Both steam and high temperature water have their place, and your particular requirements will determine which is best for you. In either case, the complete C-E line includes a type and size of boiler exactly suited to your needs. Where high temperature (HT) water seems indicated, it affords such important advantages as:

1. **The higher available heat in HT water — many times that of steam at the same pressure.**
2. **Closer control of temperature.**
3. **Heat loss is lower with the HT water closed system . . . unused heat returns to the boiler . . . no condensate return lines.**
4. **No elaborate feedwater treatment required. Make-up requirements are exceptionally low.**
5. **Steam traps not required — trap problems and attendant expense are eliminated.**
6. **No blowdown losses . . . no safety valve vent losses . . . no condensate losses.**

The planning of any new heating and/or processing system should include the consideration of a high temperature water system. There are many hundreds of HT water installations operating abroad and a rapidly growing number in the U. S. A. It may be *just right* for *your* requirements.

B-886 C

Advantages of the C-E "HT" Water Boiler

Once it is established that HT water is right for your needs, your next concern is selection of proper equipment. The C-E high pressure, high temperature water boiler has inherent advantages that make it the best possible choice. It is especially designed for HT water applications utilizing as it does the principle of forced, controlled circulation which is extended throughout the entire system. This accounts for numerous points of superiority in the C-E LaMont Controlled Circulation Hot Water Boiler. Among these are:

1. **Complete control over HT water movement in both system and boiler.**
2. **No separate boiler pump is required, since low pressure loss is inherent.**
3. **Pressurized operation with oil or gas means no induced draft fan.**
4. **Single-pass design — no baffles — means cleaner boiler and lower draft loss.**
5. **More efficient heating surface can be arranged because of controlled, positive circulation.**
6. **Any fuel — oil, gas, coal, or any combination of fuels.**
7. **Other features such as: gastight, welded steel casing . . . fewer headers, all of which are accessible.**

The C-E LaMont Controlled Circulation Hot Water Boiler is available in sizes ranging from 10 to 200-million Btu per hour, or more, with pressures up to 500 psi and temperatures to 475 F — higher if required.

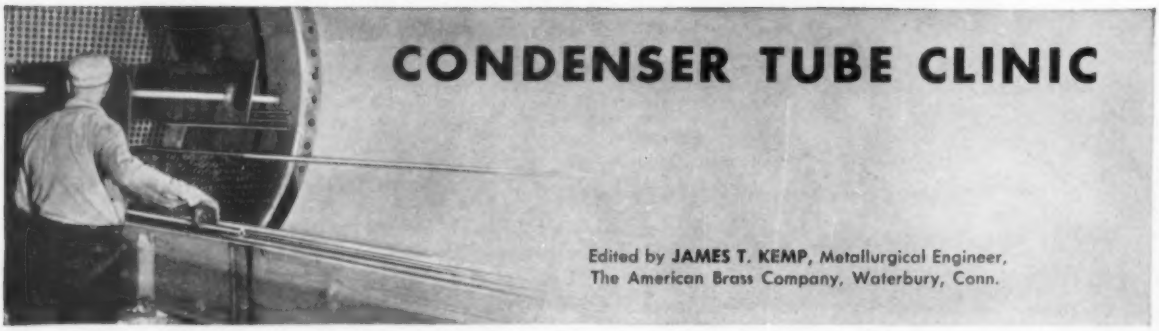
If you are in the market for a heating or process system — or expect to be — by all means investigate high temperature water and the C-E "HT" Water Boiler. Our engineers will be pleased to discuss the subject with you or your consultants. Write for our new catalog HT-112.

COMBUSTION ENGINEERING

Combustion Engineering Building • 200 Madison Avenue, New York 16, N. Y.
CANADA: COMBUSTION ENGINEERING-SUPERHEATER LTD.

STEAM GENERATING UNITS; NUCLEAR REACTORS; PAPER MILL EQUIPMENT; PULVERIZERS; FLASH DRYING SYSTEMS; PRESSURE VESSELS; DOMESTIC WATER HEATERS; SOIL PIPE

For more data circle 506 on Post Card

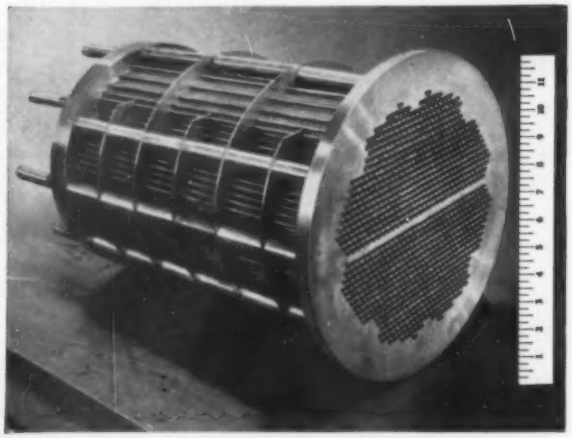


CONDENSER TUBE CLINIC

Edited by **JAMES T. KEMP**, Metallurgical Engineer,
The American Brass Company, Waterbury, Conn.

20" x ¼" O.D. Tubes need Same Care and Attention as large 60-foot Condenser Tubes

The Tube Bundle shown below is only 12 inches in diameter and 20 inches long. It is the heart of the compact, efficient lubricating-oil cooler built by the Andale Company, Lansdale, Pennsylvania.



In each bundle there are 946 tubes, each 20 inches long, ¼-inch O.D. by 0.035-inch wall thickness. They are of ANACONDA Phosphorized Arsenical Copper-108 for fresh-water duty or of ANACONDA Ambraloy-927 (Aluminum Brass), ANACONDA Cupro Nickel, 10%-755, or ANACONDA Cupro Nickel, 30%-702 for salt water. They are expanded in high-strength rolled ANACONDA Ambraloy-917 (Aluminum Bronze) tube sheets.

When the tubes are brass, the complete tube bundle is stress-relieved as an assembly at a temperature of 550 F.

These small tubes—cut to short lengths, with ends burnished, highly finished surfaces inside and out, close dimensional tolerances—are typical of The American Brass Company's product, although at the lower end of the schedule of sizes.

The Same Precision in control of alloy, dimensions, anneal or temper governs the manufacture of all ANACONDA Heat Exchanger Tubes in the plants of The American Brass Company—from these little oil-cooler tubes on up to the largest sizes used in sugar evaporators, and the long lengths needed in high-pressure feed-water heaters in steam power stations.

Full Range. ANACONDA Heat Exchanger and Condenser Tubes are made for all sizes and kinds of shell-and-tube, submerged, spray-tower, and finned-atmospheric heat transfer equipment—for operation at elevated temperatures in conformance with ASME standards for allowable stresses.

Technical Assistance. Our Technical Department is regularly helping manufacturers, electric companies, marine operators, petroleum and chemical companies to select the correct tube alloy for many types of condensers and heat exchangers. This service is available to you without obligation. Write: The American Brass Company, Waterbury 20, Conn. In Canada: Anaconda American Brass Ltd., New Toronto, Ontario.

ANACONDA®

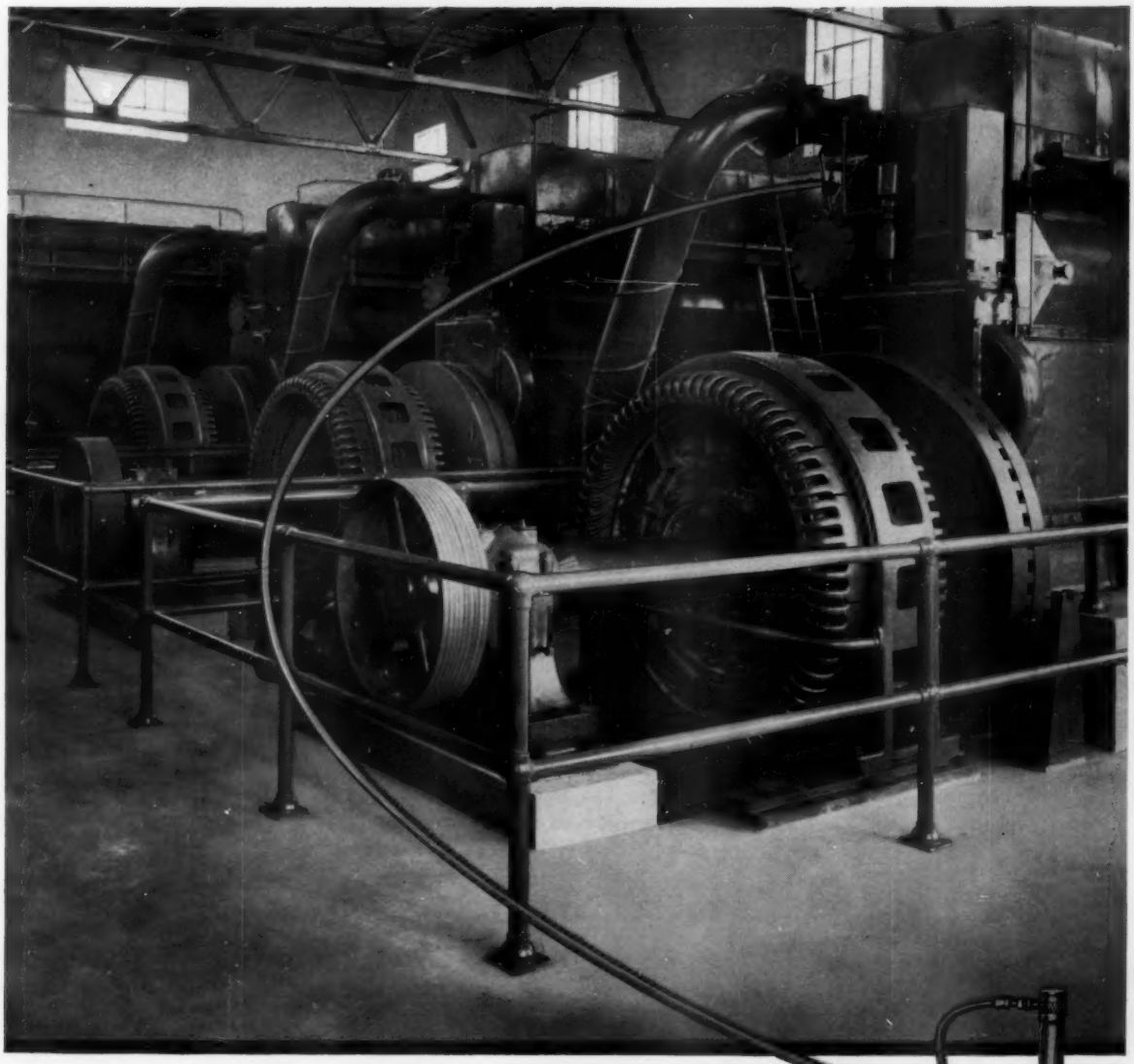
Tubes and Plates
for Condensers and Heat Exchangers

PHYSICAL PROPERTIES OF ANACONDA CONDENSER TUBES*

ALLOY	Tensile Strength, psi	Yield Strength at .5% Elongation Under Load, psi	Elongation in 2", %	Rockwell Hardness, B Scale	Density, Lb. per Cu. In.	Thermal Conductivity, B.T.U./Sq. Ft./In./Hr./°F. at 68° F.	Average Coefficient of Linear Thermal Expansion per °F. (77-572 F.)
Arsenical Admiralty-439	52,000	22,000	60	6-45	0.308	768	.0000112
Ambraloy-927	60,000	27,000	55	35-65	0.301	696	.0000108
Ambraloy-901	60,000	30,000	60	30-60	0.295	552	.0000099
Cupro Nickel, 30%-702	55,000	22,000	50	30-60	0.323	204	.0000090
Cupro-Nickel, 10%-755							
Light Annealed	44,000	22,000	46	25	0.323	314	.0000093
Light Drawn	60,000	57,000	15	68			
Red Brass-24	42,000	15,000	50	0-30	0.316	1104	.0000104
Ambronze-421	46,000	20,000	55	0-30	0.316	830	.0000102
Phosphorized Arsenical Copper-108							
Light Drawn	40,000	35,000	20	20-50	0.323	1344	.0000098
Hard Drawn	54,000	50,000	8	50-70			
Phosphorized Copper-103							
Light Drawn	40,000	35,000	20	20-50	0.323	2364	.0000098
Hard Drawn	54,000	50,000	8	50-70			

*Note: The above values are approximate and should not be used for specification purposes. *Light annealed except as noted.*

For more data circle 507 on Post Card



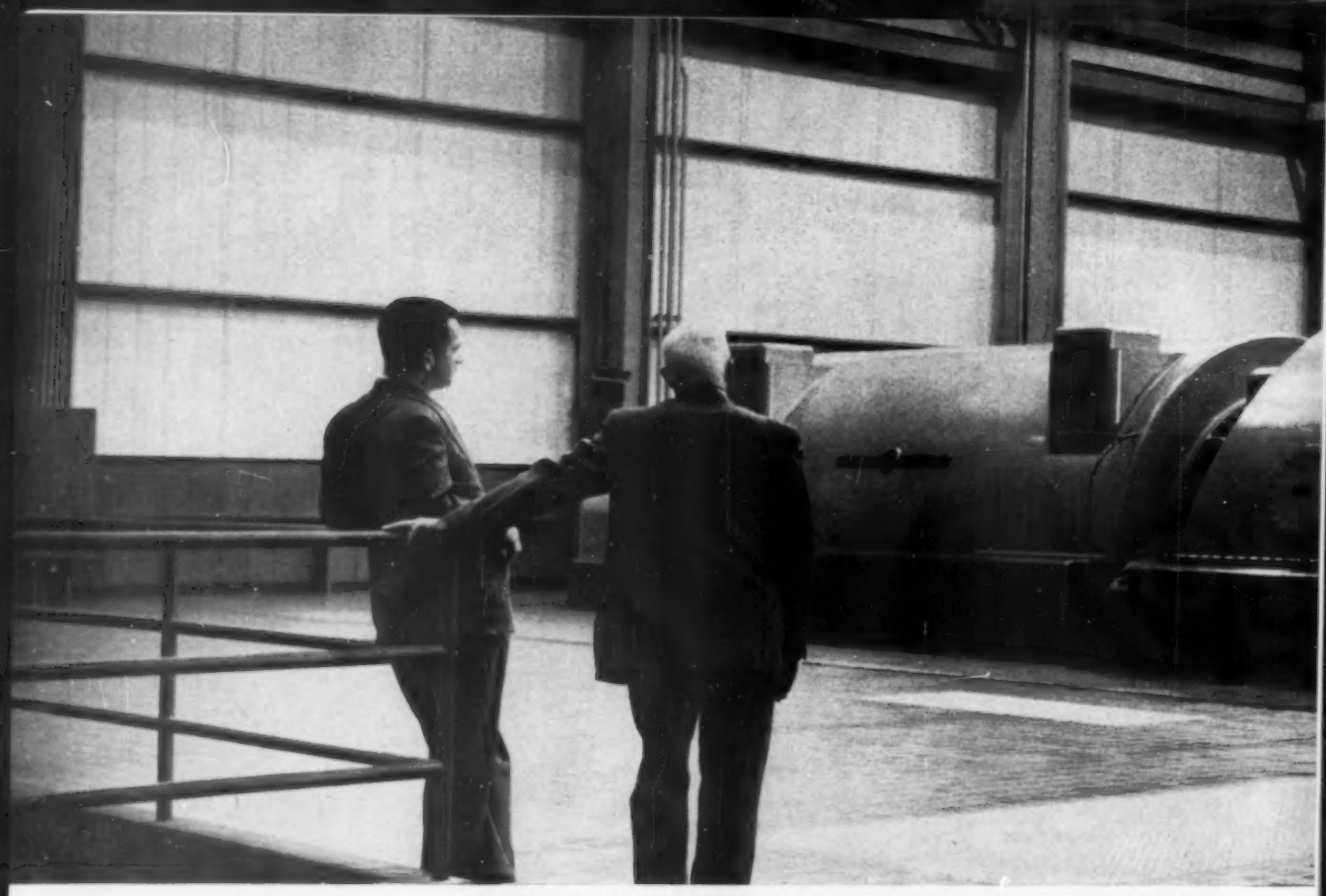
NO STUCK RINGS!

Stop the formation of varnish, sludge and carbon in your Diesels and *keep it stopped* with Sinclair RUBILENE®, the high viscosity index oils proved by over 35 years in industrial Diesel applications. RUBILENE earns its reputation by its performance under continuous operation and heavier loads. It fights deposits and gives better protection to cylinders, pistons, rings and other vital moving parts. Your Diesel stays on the job longer . . . service time is cut 'way 'way down!

Let RUBILENE help solve your lubrication problems. Regardless of the make or age of your Diesel, where a high VI oil is needed, there's a member of Sinclair's RUBILENE or RUBILENE HD family that meets your requirements exactly. Call your local Sinclair Representative for further information or write for free literature to Sinclair Refining Company, Technical Service Division, 600 Fifth Ave., New York 20, N. Y. *There's no obligation.*

SINCLAIR RUBILENE OILS

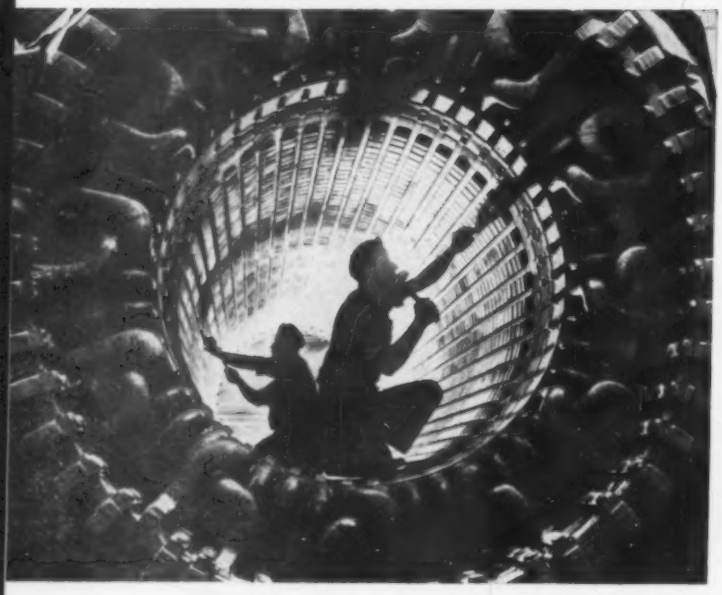
For more data circle 508 on Post Card



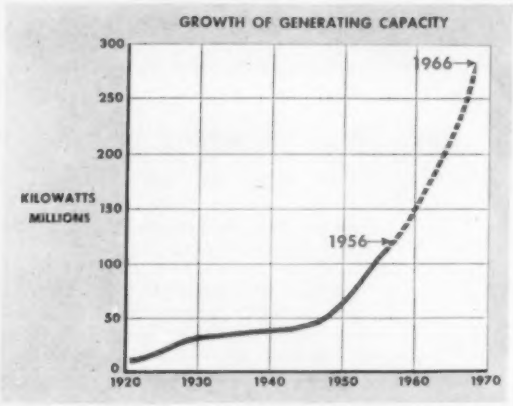
CAREFUL PLANNING FOR PRODUCTIVE MAINTENANCE INCLUDING STOCKING SPARE PARTS

How *Productive* Maintenance can help

TO MEET TOMORROW'S EXPANDING LOADS



THE FACILITIES of the world's finest turbine plant and 46 service shops located throughout the country back your General Electric unit.



G.E. works with electric utilities and consulting engineers in these vital turbine-generator areas:

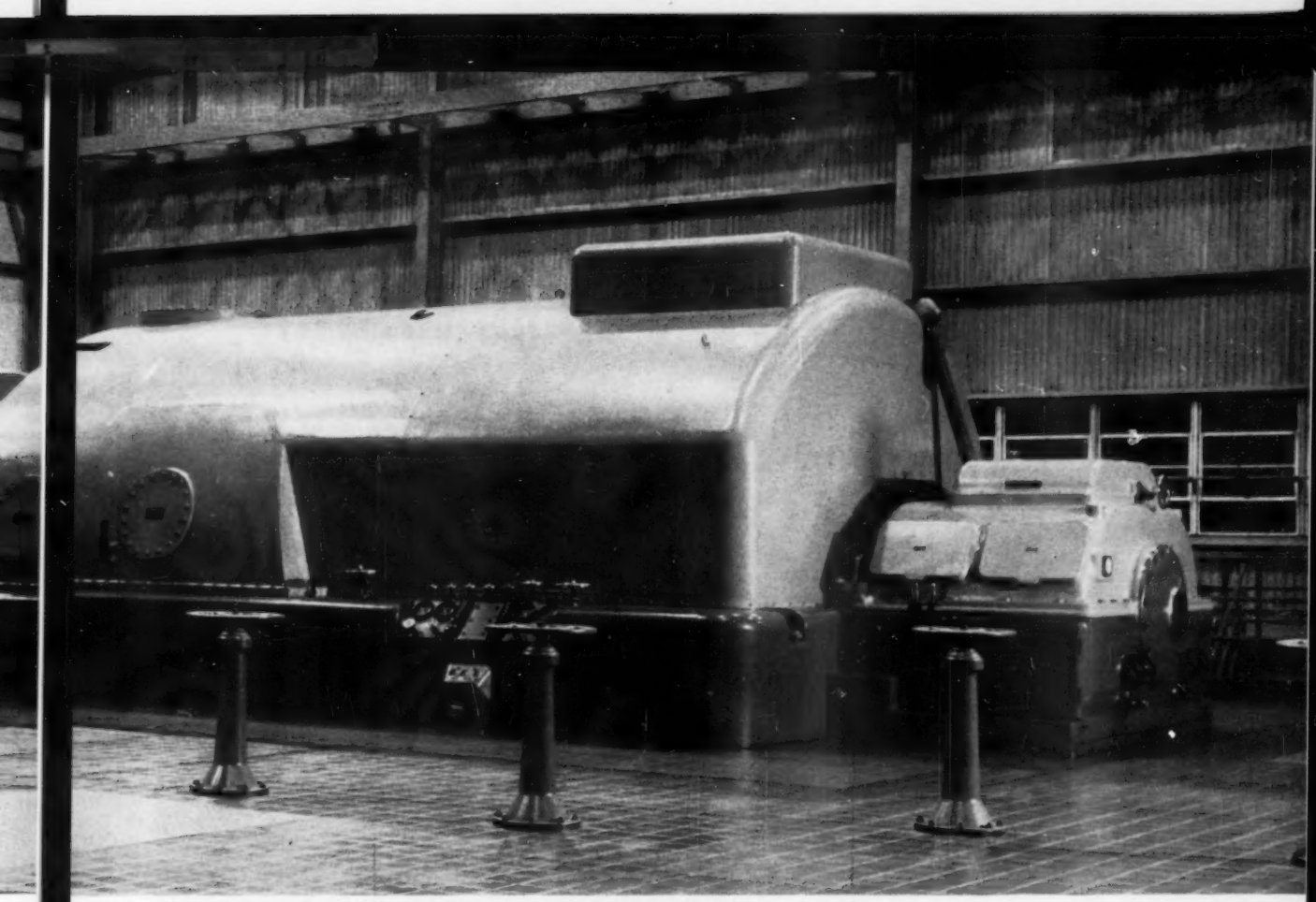
BASIC RESEARCH

APPLIED RESEARCH

PRODUCT DEVELOPMENT

TESTING

MAINTENANCE: PRODUCTIVE MAINTENANCE



AND REVIEWING SCHEDULED OVERHAULS CAN REDUCE TURBINE-GENERATOR DOWNTIME.

keep a turbine-generator on-the-line

General Electric's *Productive* Maintenance plan can help you reduce turbine-generator maintenance expenses. Here's how:

1) **Maintaining a supply** of General Electric spare parts can save valuable time. These parts fall into three categories:

a) Recommended parts such as thrust rings, springs for packing seals, brushes and brush holders, gaskets for control mechanisms, studs and nuts;

b) Optional spares such as rings for packing seals, bushings for control mechanisms, bearings and sealing rings for oil pumps; and

c) Major parts such as main bearings, rotors and stator bars.

G.E. can help you decide which to carry.

2) **By using General Electric renewal parts** and inspection service you get complete and accurate information about construction and engineering characteristics for your G-E unit. This means fast service and thorough engineering. General Electric is familiar with your machine and at the time of planning overhauls can suggest possible modernization.

3) **With the trend toward more uniform loads** throughout the year—both summer and winter—scheduling outages is becoming a real problem. Your General Electric turbine-generator representative can help you plan your overhaul schedule. By applying G.E.'s *Productive* Maintenance plan, and where operating conditions warrant, it may be possible to extend the time between overhaul periods.

You can get service 24 hours a day, seven days a week if necessary on your General Electric unit. The world's most modern turbine-generator manufacturing facilities and 46 G-E service shops are ready to help you.

Planning *Productive* Maintenance is just one of many areas in which General Electric is co-operating with electric utilities to prepare for tomorrow's load growth today. For more information write for bulletin GEA-6087. Large Steam Turbine-Generator Department, General Electric Company, Schenectady 5, New York.

254-46

Progress Is Our Most Important Product

GENERAL ELECTRIC

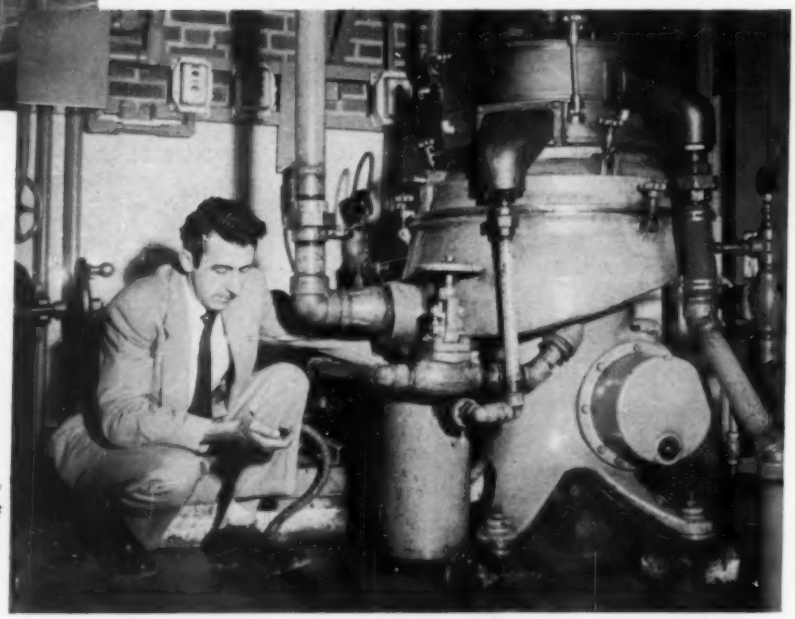
For more data circle 509 on Post Card

DE LAVAL AC-VO CENTRIFUGE SAVES EDMUNDSTON $30,638 IN ONE YEAR!

The City of Edmundston power plant in New Brunswick adds another story of tremendous savings through the use of residual fuel—purified by De Laval.

With #2 diesel fuel costing 15½¢, and residual 9¼¢ per gallon... there is a gross savings of 6¼¢ per gallon when residual fuel is used. Mr. L. Long, Electrical Superintendent says: "A total of 490,216 gallons of #6 fuel was burned from May 1, 1955 to May 1, 1956. *Gross savings amounted to $30,638.50.*

Baldwin-Lima-Hamilton diesel engine at City of Edmundston power plant in New Brunswick.



De Laval AC-VO "Nozzle-Matic" Continuous Purifier at City of Edmundston plant.

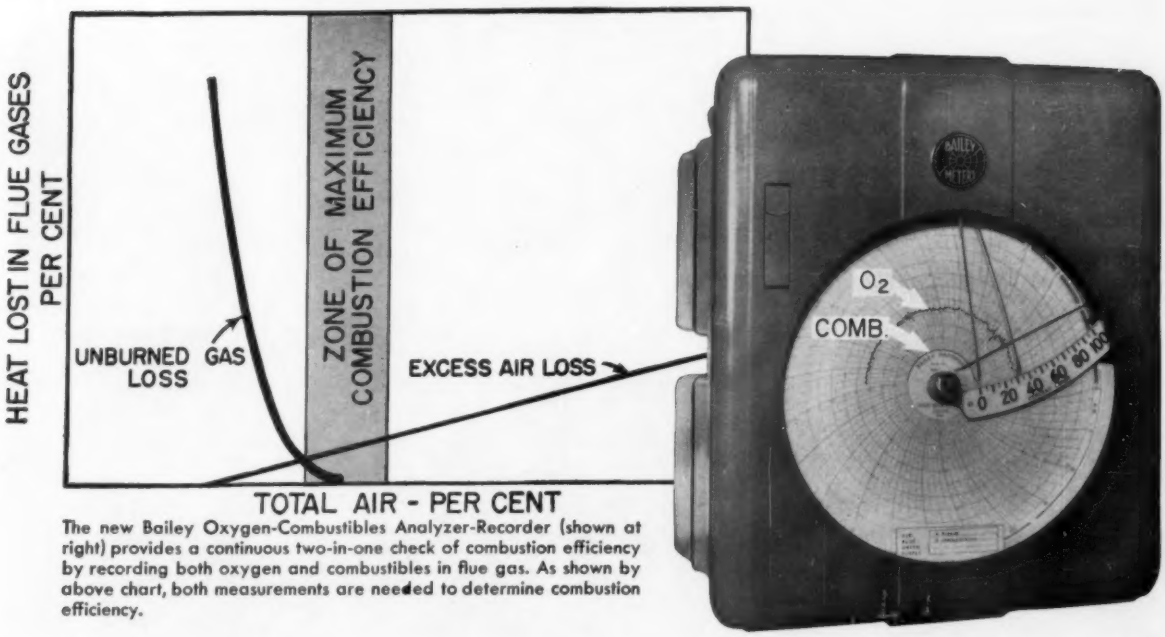
Mr. Long says "the De Laval AC-VO removed some 5,280 gallons of sludge. The engine operated 4912 hrs. on heavy fuel. A thorough inspection showed that fuel injection equipment, bearings, gears, etc., were in excellent condition."

Get tremendous savings with low-cost heavy fuel oil—*purified by De Laval!* Write for details... today!

DE LAVAL SEPARATOR COMPANY

THE DE LAVAL SEPARATOR COMPANY Poughkeepsie, New York • 427 Randolph St., Chicago 6 • DE LAVAL PACIFIC CO. 201 E. Millbrae Ave., Millbrae, Calif.

For more data circle 510 on Post Card



The new Bailey Oxygen-Combustibles Analyzer-Recorder (shown at right) provides a continuous two-in-one check of combustion efficiency by recording both oxygen and combustibles in flue gas. As shown by above chart, both measurements are needed to determine combustion efficiency.

BAILEY announces • • •
New 2 in 1 way to measure Combustion Efficiency

The new Bailey Oxygen-Combustibles Analyzer-Recorder gives you a continuing double check on combustion economy. It's fast response measures and records:

1. Excess air—regardless of the fuel or combinations of fuels being burned.

2. The mixing efficiency of your fuel-burning equipment—by indicating the amount of combustibles in your flue gas, resulting from incomplete mixing of fuel and air.

Combustion efficiency depends upon fuel-air ratio. Too much fuel can be even more costly than too much air. And because of the interdependence of these two factors, no control that measures only one of them can give you complete protection.

Now, for the first time, you can check *both* with a *single* fast acting instrument, using the new Bailey Oxygen-Combustibles Analyzer-Recorder for industrial furnaces, kilns, heaters and boilers.

Fuel economy improves as excess air is reduced —until unburned fuel begins to show up in the flue gas. When this happens, combustion efficiency drops off sharply if there are further decreases in the air-fuel ratio. That's why combustion gases must be analyzed for *both* oxygen and combustibles to get a true indication of efficiency—and that is why Bailey coordinates both measurements on the same chart, to show when excess air may be reduced safely without danger of greater losses from unburned gases.

The Bailey Oxygen-Combustibles Analyzer is an approved combustion safeguard.

Ask your local Bailey engineer for suggestions on application. Equipment details in Product Specifications E65-1 and E12-5. P31-1

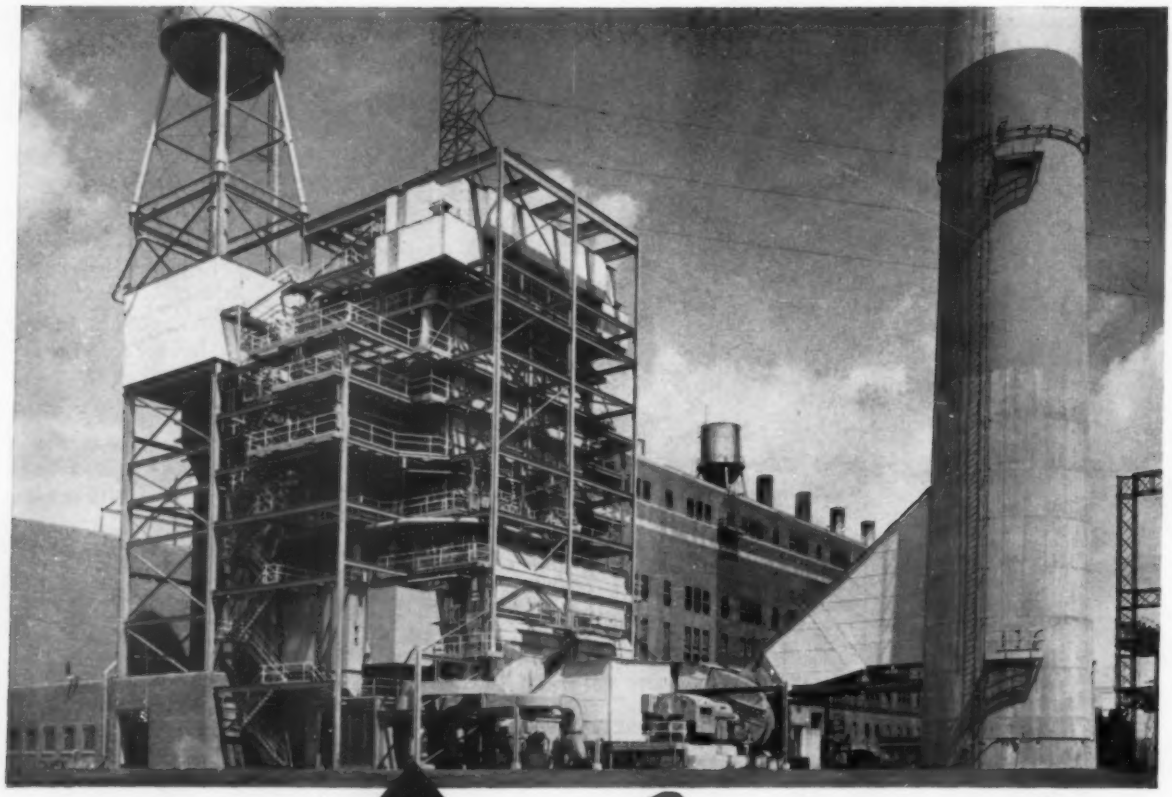
BAILEY METER COMPANY

1040 IVANHOE ROAD • CLEVELAND 10, OHIO

INSTRUMENTS AND CONTROLS

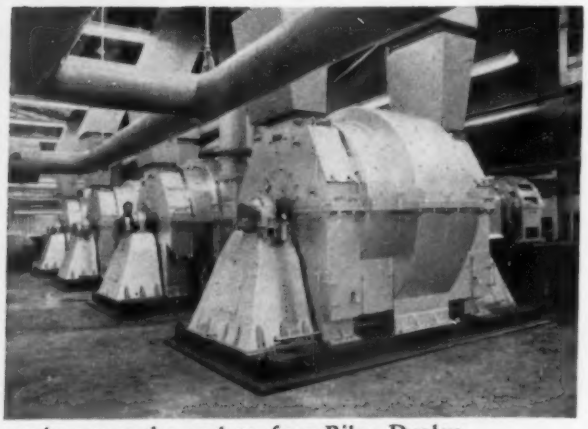
For Power And Process

For more data circle 511 on Post Card

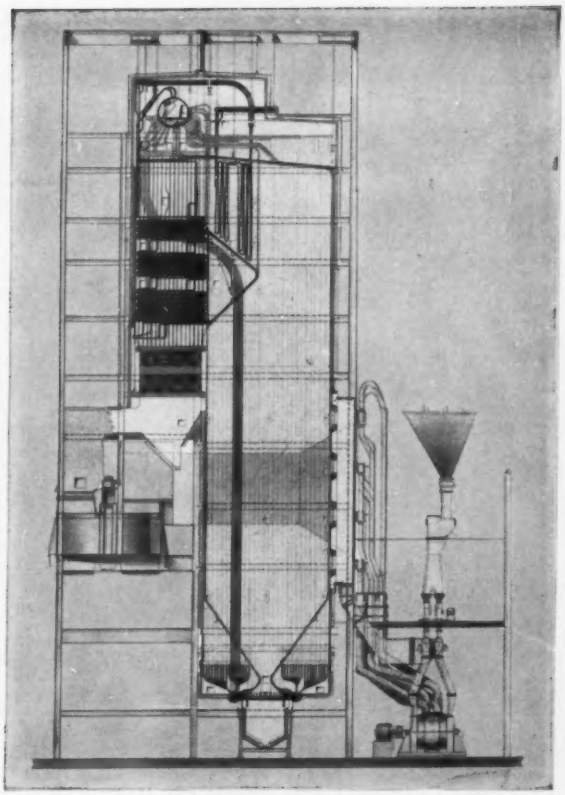


On the line.

Actual unretouched burner elevation view inside Picway's Riley Furnace after 80,000 tons of low ash fusion temperature coals had been fired. Low incidence of slag formation around burners is due to the Riley design of water-cooled burner throats.



Eight Riley Coal Feeders at Picway Station accurately meter the coal to four Riley Duplex Pulverizers. Riley Pulverizers are distinguished for their quiet, smooth, vibrationless operation, their ability to respond to rapid load swings, and their ability to handle wet coals. Tungsten Carbide faced pulverizing elements assure sustained high fineness and low maintenance.



THE new 100,000 kilowatt electric generating unit recently placed in service at Columbus and Southern Ohio Electric Company's Picway Generating Station located a few miles south of Columbus, Ohio, is supplied by a 900,000 lb/hr. Riley Unit that is designed to operate as a swing load unit using Ohio Strip Mine Coals.

The unit features an ample furnace and is fired by four Riley Duplex Pulverizers and twelve Riley Flare Type Coal Burners. This combination of Riley equipment is ideally suited to meet the wide swings in load of the new generating unit.

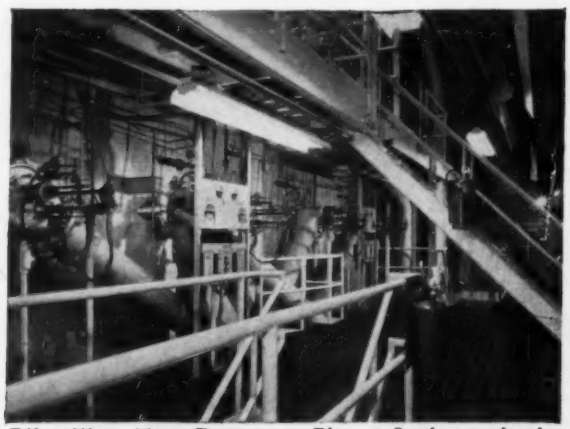
Picway's New Riley Unit

This new generating unit of Picway Station increases the total installed generating capacity of Columbus and Southern Ohio Electric Company to 560,000 kilowatts, representing an increase of 165% during the past 10 years.

Engineering Data

Maximum steam capacity —	900,000 lbs/hr.
Design Pressure	1500 psig
Steam Temperature	950 F

Commonwealth Associates, Inc., Engineers



Riley Flare Type Burners at Picway Station maintain continuous, stable ignition at low loads. A common air duct supplies secondary air. Direction and rotation of burner flames is by remote control.

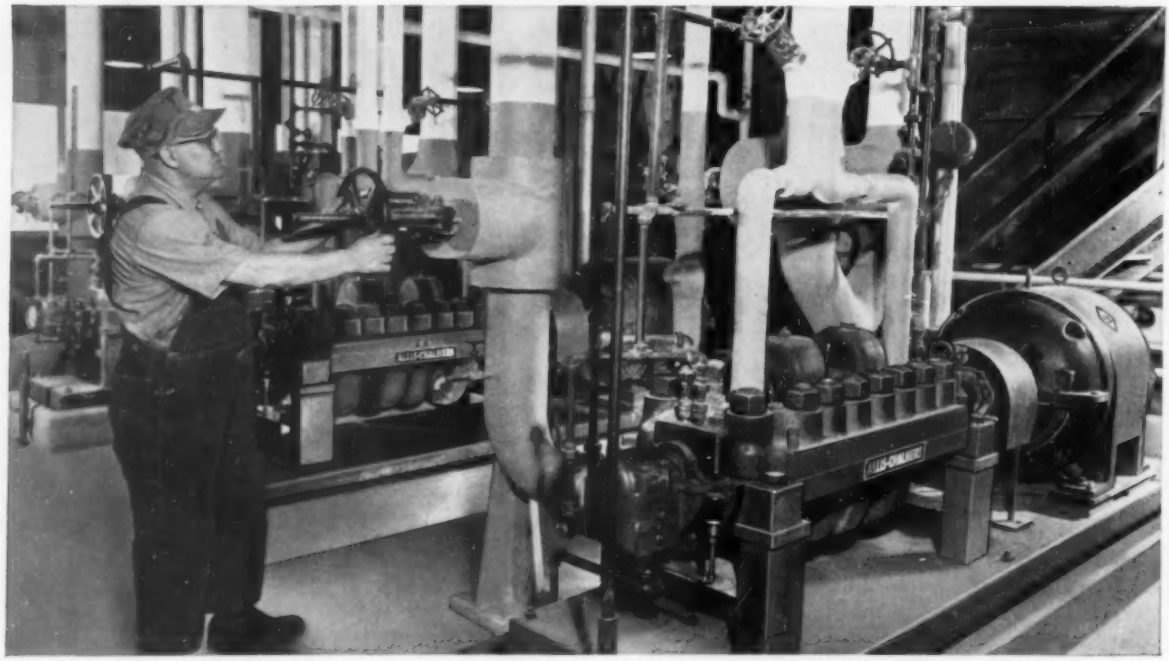
A survey of your plant by a consulting engineer could show ways of making surprising savings in your power costs.

RILEY
Stoker Corporation
WORCESTER, MASSACHUSETTS

Sales Offices: Worcester, New York, Philadelphia, Buffalo, Pittsburgh, Cleveland, Detroit, Chicago, Cincinnati, Charlotte, New Orleans, Atlanta, St. Louis, Kansas City, St. Paul, Houston, Denver (Englewood), Salt Lake City, Los Angeles, San Francisco, Portland, Seattle.

For more data circle 512 on Post Card

Allis-Chalmers Pumps Meet Power Plant Requirements



New Pumps Give Milwaukee County Institutions

. . . Dependable Power Service

THESE modern multi-stage high pressure pumps assure continuous, economical steam for the Allis-Chalmers 3000-kw steam turbine units at the Milwaukee County Institutions.

As new members of the Allis-Chalmers complete line of pumps, these units are designed to meet medium-high pressure, continuous service requirements of boiler feed duty in lower volume ratings.

Horizontally split casing with suction and discharge in lower half provide for simplified maintenance—without disturbing piping. Both radial and axial balance maintains close clearances and fits, gives low thrust bearing loads. Bearings are double-row ball bearings or alternate sleeve bearing with Kingsbury thrust. Sleeve and Kingsbury combinations have ring oiling as well as pressure lubrication.

You get **MORE** than a Pump . . . When You Specify Allis-Chalmers

You can take advantage of Allis-Chalmers wide experience in supplying pumps to all industries. You are assured of modern design, heavy duty construction and correct application aid — all adding up to years of dependable service.

Allis-Chalmers is the only company that can offer you "One-Source" responsibility, with a complete unit — pump, motor and control — all built to work together. For "MORE" information about Allis-Chalmers pumps, call your local A-C office, or write Allis-Chalmers, General Products Division, Milwaukee 1, Wisconsin.

ALLIS-CHALMERS

A-C ALLIS-CHALMERS

A-5098

For more data circle 513 on Post Card

Hoot Mon!

if it's thrifty ye be
LOOK INNA THIS...

ADAMANT® FIRE BRICK CEMENT

The savings in "outage", time and, of course, *money* is bonnie well what our canny Scot is referring to here . . . famous ADAMANT, the *original* high temperature cement, is literally *unbeatable* as a bonding agent. ADAMANT joints are gas-tight, metal-tight, withstand vibration . . . effectively resist abrasive action of dust-laden air . . . and, ADAMANT sets without shrinking or cracking . . . maintains its bond throughout temperature range. In fact, for the many varied, practical uses for popular ADAMANT, write for the new Refractory Bonding Mortars Catalog #3.

Yellow pages of 'phone book have your nearest ADAMANT Distributor.

Botfield
ESTABLISHED 1907
REFRACTORIES

ADAMANT and other ADA products

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from Your *Nalco*® REPRESENTATIVE

● Nalco Representatives make friends and permanent Nalco System users with a simple formula: honest water treatment service.

You can ask your Nalco Representative questions and get straightforward answers . . . And if you stump him, he—and you—can put the whole Nalco Laboratories' and Service staffs to work on a plain-language plan of action to get you better water treatment results, most economically.

If you are not already getting the security from water treatment troubles that regular calls from your Nalco Representative bring, call or write today for prompt action.

Nalco WATER TECHS

A paper on "A Laboratory Method for the Study of Steam Condensate Corrosion Inhibitors," presented at the 8th Annual Conference, National Association of Corrosion Engineers, has been reprinted by Nalco for distribution to men interested in this problem. Your copy will be sent free upon request.

NATIONAL ALUMINATE CORPORATION
6224 West 66th Place • Chicago 38, Illinois
In Canada: Alchem Limited, Burlington, Ontario

THE *Nalco* SYSTEM . . . Serving Industry through Practical Applied Science

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HELPFUL BULLETINS

INSTRUMENTS AND CONTROLS

101 Power Plant Control — Reviewed in detail in 12-pp Bulletin 1022A are combustion and boiler feed water control, pressure reducing, desuperheating and automatic soot blowing, the latter including retractable and rotary soot blowers. Photos and diagrams illustrate design and operation features. Copes-Vulcan Div., Blaw-Knox Co.

102 Thermostatic Controls — Eight-pp Catalog C-7, on thermostatic control valves, contains descriptive and engineering data on shower mixing valves, steam temperature regulators, water controllers, specialized control assemblies, tempering valves. Highlighted is a new concealed shower mixing valve. Lawler Automatic Controls, Inc.

103 Gages, Indicators — Bulletin 8-1-56, 6 pp, provides illustrated catalog information on a broad variety of boiler water gages, liquid level gages, gage glasses, flow indicators and related equipment. Sizes, pressure ratings and other pertinent data are included. Ernst Water Column & Gage Co.

104 Bin Level Indicator — An instrument which indicates or controls level of dry, pulverized, fine, crushed and granular materials passing into or out of a bin, silo, or bunker is described in Bulletin I-5A. Two principal functions — high level and low level control and indication — are detailed, and mechanical and electrical characteristics are described. Fuller Co.

New and revised publications reviewed on these pages offer help on operating and maintenance problems. To order, use the handy Reader Service Cards provided on pages 113 and 114.

105 Humidity Instruments — Bulletin H1009, 22 pp, describes and illustrates humidity recording and controlling instruments, as well as accessories. Contains information on indicating, recording, and automatically controlling wet and dry bulb instruments, and psychrometers. Models for permanent mounting and portable models are shown. Also provided in bulletin are conversion tables of wet and dry bulb temperatures and psychrometric tables. The Bristol Co.

ELECTRICAL

106 Open Motors — Latest design features of company's open drip-proof motors in NEMA rerated ratings of ½ to 40 hp (type G) and in non-rerated ratings of ½ to 100 hp (type AP and APWW) are described in 6-pp Bulletin 51B6210G. In addition to cutaway views of motor, bulletin includes tables of ratings and dimensions as well as a horsepower frame chart. Allis-Chalmers Mfg. Co.

107 On D-C Motors — Six-pp illustrated Bulletin 53B8424 describes direct-current motors, ½ through 200 hp, and motor-generator sets up through 200-kw output. Covers shunt and stabilized shunt wound, compound wound and series wound motors in eight enclosures plus a matching line of motor-generator sets for conversion of a-c to d-c. Bulletin provides cutaway view of a motor, showing design details, along with line drawings showing a variety of frame sizes. Allis-Chalmers Mfg. Co.

108 Motor Buying Tips — Bulletins GEC-1026A and GEC-1027A, each 11 pp, give buying information on a selected group of this manufacturer's motors. Included are application data, ratings and prices for fractional horsepower motors, integral-horsepower polyphase and single phase induction motors, motors and control for part-winding starting, gear-motors and resilient-base integral horsepower induction motors. General Electric Co.

109 Magnetic Starter Modification — Illustrated Bulletin GEA-6481, 12 pp, shows how to modify company's standard magnetic starters to fit special conditions. Includes how-to-do-it pictures of installation processes with a push button and selector switch, auxiliary interlock, strongbox coil, 3rd overload relay, and fuse clip kits. General Electric Co.

110 Circuit Breakers — Bulletin 1004-A features large air circuit breakers and heavy duty d-c circuit breakers for protection of all vital circuits. Photos illustrate features of the various models available and tables list complete ratings. I-T-E Circuit Breaker Co.

111 For Voltage Correction — Ways in which the Handi-Auto transformer can be used to help solve voltage correction problems are told in Bulletin 61B8490. Includes diagrams of connections for the transformer, along with mechanical information concerning the unit. Allis-Chalmers Mfg. Co.

112 Isolated Phase Bus — Twenty-pp Bulletin GEA-5460A contains descriptive, application and dimensional information pertaining to unit supported isolated phase buses. Discusses the "zero force" principle which makes unit support design possible, tells how to plan a bus layout, and includes table of ratings, weights and dimensions. Also describes forced-air cooled design. General Electric Co.

113 Stationary Batteries — Advantages of the positive-plate design of company's line of batteries for stationary power services are described in 6-pp Form 5916. Photos show how spiral buttons of Planté-type plates provide a reserve supply of lead and an effective working area more than five times the plane surface of the plate, to give long battery life and superior performance. Exide Industrial Div., The Electric Storage Battery Co.

114 Electrified Baseboard — Eight-pp Form 590 tells the complete story of company's electrified baseboard for wiring and re-wiring. Illustrates and describes advantages from the point of view of architects, builders and electrical contractors, and shows applications in commercial and industrial buildings where multiple electrical outlets and additional circuits are needed. Installation sketches are included. The Wiremold Co.

115 Selenium Rectifiers — Bulletin GEA-6545, 12 pp, gives features, application, charts, construction, dimensions, specifications and other data on ¾ kw to 125 kw selenium rectifiers as well as multiples to 500 kw. Performance curves are included, as well as dimensional and rating tables and dimensional diagrams. General Electric Co.

PUMPS, COMPRESSORS

117 Pump Troubles Diagnosed — Bulletin PC-508P is designed to help locate and correct common ailments of rotary, centrifugal, and steam pumps. Cartoon sequence pictures give full description of pump troubles — from failure to deliver water to the loss of capacity after starting. Worthington Corp.

118 Rotary Pumps — Described as a "continuity" catalog, this 20-pp publication defines company's entire internal gear rotary pump line, organized into five basic series. Catalog begins with three sets of selection tables, which let you apply known problem information to first table, giving proper pump groups from which to make a selection. You then apply the derived information to next page, where power, speed and gallonage are covered for liquids of various viscosities at different pressures. Last table contains a list of liquids, their viscosities and specific gravities, and other data. The Wayne Pump Co.

119 On Paper Stock Suspensions — Application Data Bulletin 780.4, 16 pp, describes the friction of paper stock suspensions in pipes based on a correlation by the University of Maine of the Brecht and Heller data. Contains pump selection data for pumps handling paper stock suspensions, noting factors affecting operation such as suction piping, suction head, characteristics of various paper stock consistencies, consequences of air in the piped stock, others. Use of filters and additives are also discussed, and friction curves of paper stock in elbows and fittings and a conversion chart to determine capacity in gpm of a pump handling paper stock included. Goulds Pumps, Inc.

120 Portable Compressor — Form 2307, 6 pp, announces the addition of a new 85 cfm size to company's line of Gyro-Flo compressors. Describes design and operation features and includes complete specification data on this lightweight compressor designed for trouble-free performance and economy on smaller jobs. Ingersoll-Rand Co.

SAFETY AND FIRE PREVENTION

121 Safety Device Selection, Use — These two publications include an 8-pp catalog and price list on company's safety devices for steam and hot water, and a 16-pp service guide, (Bulletin M-71.) The former gives application suggestions and necessary ordering information on feeders and feeder cut-off combinations, low water cut-offs, pressure and temperature relief valves. The practical little service guide provides tips on piping hook-ups, testing,

trouble shooting, and replacements. McDonnell & Miller, Inc.

122 Safety with Flammables — A practical explanation of the nature and safe plant use of flammable liquids is presented in this file of three bulletin sheets. Covers their characteristics, hazards and safe handling. Available in a loose leaf file they are the first of a series which, when completed, will cover safe practices in every division of a typical plant from receiving to disposal. Subsequent issues of the bulletins will be sent to those requesting original issues. The Protectoseal Co.

123 Fire Resistance Ratings — This 8-pp booklet contains fire-resistance ratings for plaster, acoustical plastic, and concrete structure, including columns, beams, girders and trusses, floors and roof decks, concrete non-bearing panel or spandrel walls, solid plaster partitions. Fireproofing details are fully illustrated with cutaways. Vermiculite Institute.

VALVES, PIPING AND ACCESSORIES

124 Bronze Gate Valves — Bulletin 566 describes and illustrates company's 125 lb bronze gate valves, featuring cylindrical design and increased weight construction for longer life and completely interchangeable parts in valves of the same size. Contains size and dimensional details. Kennedy Valve Mfg. Co.

125 Lubrication Spray Valves — Bulletin 60-A, 8 pp, provides complete information on company's spray lubrication systems for open gearing and slide surfaces. Offers descriptions of manual and automatic systems and component equipment with schematic layouts as well as application views. The Farval Corp.

126 On Plastic Pipe — Ace Supplex flexible polyethylene plastic pipe and fittings are described in 8-pp Bulletin CE-57. Gives applications for the pipe, sizes of standard pipe and fittings, installation instructions, properties, and estimated flow rates for water in various pipe sizes. A chart lists many common industrial liquids — acids, bases, organic chemicals, etc. — and tells which may be carried in this piping. American Hard Rubber Co.

127 Plastic Pipe, Fittings — Advantages, applications, easy installation of company's polyethylene pipe and fittings are discussed in this 8-pp catalog section. Specifications and chemical resistance data are presented in tabular form. Flexible, semi-rigid and rigid types are covered, and fittings for each type are shown. Goodall Rubber Co.

128 Rigid Pipe — This 8-pp illustrated bulletin features company's line of high impact rigid Koroseal pipe, fittings and valves. Explains how pipe is installed, reviews product applications and describes physical properties, as well as use and installation of valves. A chart listing common chemicals handled is included. The B. F. Goodrich Co.

129 Leak proof Unions — Circular D-1 describes advantages of company's unions designed to give drip-tight, leakproof seal. A cutaway view showing design features, and a table of dimensions are included. The Fairbanks Co.

130 Pipe Hangers — Sixteen-pp Bulletin 156 gives complete specifications for company's line of Counterpoise pipe hangers, and provides engineering drawings of all models, weight-load selection tables, and erection and adjustment information. These hangers are designed to provide a constant load supporting capacity for piping systems subject to vertical movements caused by expansion and contraction of piping due to temperature changes. Levelglide hangers, which permit horizontal movement of piping, are also described. National Valve and Mfg. Co.

PAINTS, COATINGS

132 For Red Lead Painting — Technical Letter 11, 12 pp, covers the subject of recommended surface preparation of steel for red lead paints. In addition, it contains a handy reference table indicating recommended surface preparation methods for specific types of steel structures, red lead primers, exposure conditions and drying times. Lead Industries Association.

133 Corrosion Proofing — Bulletin CP-614A, 8 pp, describes corrosion proofing materials, including cement mortars, interliners, and protective coatings and linings. Shows how corrosion proof masonry is applied, describes applications of interliners, and includes cement mortar selection data and a resistance chart. Method of calculating cement and brick quantities is detailed, as well as estimating data for protective coatings and linings. Pennsylvania Salt Mfg. Co.

MECHANICAL POWER TRANSMISSION

134 V-S Motor Pulleys — Featured in 8-pp Bulletin 1630-B1 P are motor pulleys (⅛ through ¾ hp) available with adjustable and tilting motor bases, companion sheaves, motor bases and V-belts. Bulletin is illustrated by charts listing ratings, dimensions and selection data for the various pulleys, the 24 QD sheave stock sizes, V-belts. Worthington Corp.

135 Motor Drives — Eight-pp Bulletin 1610-B1 describes motor drives with positive pulley adjustment, ranging from ½ to 25 hp. Contains complete information on how to select variable speed drives to meet any specialized requirement, and describes engineering features, remote controls, separate motor drive, and other mechanical power transmission products. Worthington Corp.

136 Industrial Clutches, Brakes — Bulletin 500-A, 34 pp, describes features and applications of company's line of industrial clutches and brakes. Product description and specifications are included and photos, drawings and diagrams are used profusely throughout. A table lists clutch and brake applications and diagrams illustrate mounting arrangements. Dimensions in inches are tabulated, as well as torque ratings and other data. Fawick Corp.

137 Bearing Engineering Data — Besides listing a complete line of precision bearings, 128-pp Catalog 52-A features a section of engineering data and computations providing formulas for use in determining numerical values for various loads to which bearings are subjected. Information is also provided for determining forces that act on various types of gears, and formulas for determining centrifugal and inertia forces that act on bearings. Tips on factors to be considered when selecting a bearing for a particular installation are included. Also, full specifications and dimensions are given for each type and size of bearing in company's line. McGill Mfg. Co., Inc.

BUILDING MAINTENANCE

138 Aids to Window Washing — Sixteen-pp Booklet 2022-A is of particular interest to power engineers whose plants contain many windows, and window walls. It describes equipment which is attached to buildings of all heights, to let window washers raise or lower themselves and travel along walls to reach any window areas and wash them safely. Includes information on window washing cages for one or two men and for manual or electrical operation. Gives details on principal parts and fittings and provides engineering data showing how to locate and support track. Cleveland Tramrail Div., The Cleveland Crane & Engineering Co.

139 For Cleaner Floors — "Manual on Sweeping and Mopping Floors" is a 20-pp revised edition of booklet based on analysis into maintenance problems. Primarily it is a picture book with instructions on best and quickest ways to sweep and mop all types of floors. Gives methods that will streamline the work. Tells types of brush and mop to use and how to handle them; how to sweep corridors and stairs without lost effort; how to sweep large areas. Huntington Laboratories, Inc.

COOLING AND HEAT EXCHANGING

140 To Remove Process Heat — Bulletin CH-3D provides detailed technical data and description of company's Chil-er Recirculating units, including package units for pilot plants and laboratories, and explosion proof models for hazardous jobs. Includes a section containing tables, to aid in selection of proper size standard unit for specific cooling requirements. Mayer Refrigerating Engineers, Inc.

141 Water Chillers — Sixteen-pp Bulletin 5925 describes packaged water chillers for air conditioning or industrial coolings. Describes mechanical specifications for all sub-assemblies and components. Chiller element construction details are discussed; a cutaway view of this element is included. User advantages are also outlined. A recommended selection procedure is presented and several pages of tables give sufficient data to permit selection for any requirements within operating range of these units. American Blower Corp.

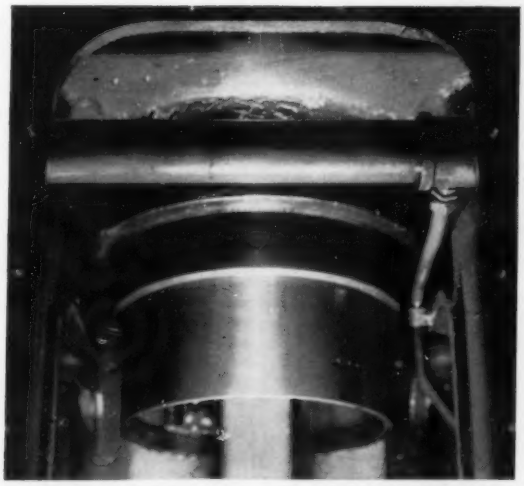
142 Liquid Chillers — Catalog 50-D, 8 pp, offers complete information on company's packaged liquid chillers for use in air conditioning and industrial cooling. Mechanical specifications are given, as well as general specifications, selection and performance tables and dimensional diagrams showing construction details. Acme Industries, Inc.

143 Heat Exchangers — Alcotwin fin-tube heat exchangers are presented in 8-pp Bulletin FH-3. Discusses heat-transfer characteristics of the longitudinal fin tubes, which feature U-shaped fin channels integrally bonded to the tubes by heliarc welding. Includes a table of dimensions, a type designation table, and finside coefficient and finside pressure-drop charts for all sizes. Alco Products, Inc.

(l. to r.) Carl Olbertz, Milford plant superintendent, "Rollie" C. Bleimehl, Standard Oil industrial lubrication specialist and Frank Morgan, Milford chief engineer inspect crankcase. Rollie Bleimehl is qualified to give technical service on jobs like this. He's been doing this sort of work for 10 years. Rollie has a mechanical engineering degree from Iowa State College and has completed the Standard Oil Sales Engineering School.

23,000 hours on original rings and bearings—no overhaul

Milford, Iowa, Light Plant gets this performance from engine using STANODIESEL Oil M



"As is" photo of piston skirt and interior of crankcase. No wiping or cleaning was done before photographing or at any time during 23,232 hours engine has been in service STANODIESEL Oil M is the lubricant.

When a new 720 H.P. Superior engine was put in service at Milford, Iowa in 1949, the plant management knew what oil they were going to use—STANODIESEL Oil M. Their choice was based on previous experience with Standard diesel oils in other engines.

After 23,232 hours of operation, the engine at Milford is still operating with the original bearings and rings. It has not been overhauled. The crankcase, as shown in the photo, is clean. Pistons are clean and bright with no sign of wear. Twice yearly, oil samples have been taken for laboratory analysis. Each time the analysis has shown the oil to be in perfect condition. Good maintenance and STANODIESEL Oil M have contributed to this performance.

Got a hard job for an oil? STANODIESEL Oil M can do it. STANODIESEL Oil M has superior stability. Its additive formula helps to (1) prevent oil viscosity build-up (2) keep crankcase, pistons, cylinder walls and other parts clean (3) control foam (4) maintain film on difficult to lubricate areas and parts.

There's a Standard Oil industrial lubrication specialist near you in any of the 15 Midwest or Rocky Mountain States. Call him for more information about STANODIESEL Oil M. Or write Standard Oil Company, 910 South Michigan Avenue, Chicago 80, Illinois.

Quick facts about
STANODIESEL Oil M

- Keeps crankcase, pistons, cylinder walls clean.
- Combats deposit and wear problems imposed by use of economy fuels.
- Maintains film on difficult to lubricate areas and parts.
- Eliminates spark plug fouling in spark ignited engines and reduces combustion chamber ash deposits in engines burning natural gas, LPG and liquid fuels.
- Eliminates fuel injector and pump sticking caused by deposits on injector barrel and plunger where fuel and lube oil commingle.

STANDARD OIL COMPANY
(Indiana)

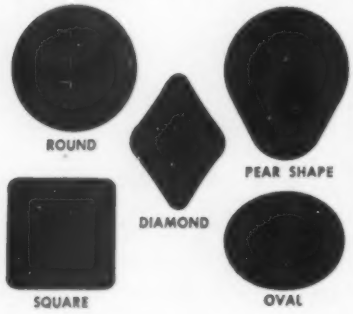
STANDARD

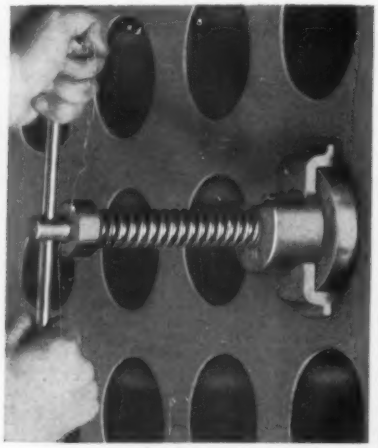
ROTO *Hand Hole* Seat Scraper

Eliminates Dirty, Tedious Work

Here is a simple, hand-operated tool for cleaning inside caps on boilers that will pay for itself many times over. This tool is equipped with retractable knives mounted on a revolving spindle having a bearing within a substantial yoke. An adjustable spring automatically maintains tension on the knives, sufficient to remove all foreign matter but not enough to cut the metal. A few turns to the right, and the job is done. A half turn to the left releases the tool. Try a Roto Seat Scraper and you'll wonder how you ever got along without one.

These are some of the hand hole shapes cleaned with a Roto Seat Scraper. Various sizes available.





Illustrating ease of operation of Roto Hand-hole Seat Scraper.

Roto Hand-hole Seat Scraper for B & W Boiler.

What Users Say—

It did a fine job. Completed the work in 80% less time.
(Engineer, Chemical Plant)

Roto Seat Scraper has paid for itself many times over on our Keeler Boiler.
(Supt., Public Utility)

One man cleaned inside cap seats on boiler header in 4 hours. Formerly took 2 men 3 days.
(Pennsylvania Manufacturer)

We also make a Reseating Machine for cleaning outside caps to assure a smooth, true fit. Send for details.

SEND FOR BULLETIN

ELLIOTT COMPANY - ROTO DIVISION
Tube Cleaner Specialists Since 1910
147 Sussex Avenue, Newark, N. J.

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144 Heat Transfer Units — How to cut heat-transfer costs in a wider range of industrial applications is told in 16-pp Bulletin IP-356. Shows how Platecoil units are constructed and engineered to overcome heat-transfer processing difficulties. Cites 10 major advantages and shows how each contributes to savings in installation, upkeep. Representative installations are pictured. Specifications and dimensions are listed for four major styles. Platecoil Div., Tranter Mfg., Inc.

OTHER EQUIPMENT

145 Package Boilers — Twenty-pp Publication B-120 describes and illustrates company's package fire-tube unit boilers available with firing equipment selected to suit plant conditions, service facilities and most suitable fuels. Some typical installations are pictured. Special advantages of these units are detailed and dimensions and engineering data provided for both low- and high-pressure models. Dominion Bridge Co. Ltd.

146 Magnetic Particle Inspection — Form 151, 16 pp, outlines important design and operation features of company's Magnaflux-Magnaglo process for magnetic particle inspection. Describes two kinds of magnetism used in the process, as well as various kinds of equipment. Application in manufacturing — in quality control, production inspection, tool inspection, machinery and equipment maintenance, transportation and service industries — are fully described, and typical kinds of defects located by the process are pictured. Magnaflux Corp.

147 Blower Selection — Bulletin B-154A contains selection charts and other useful engineering information pertaining to Standardaire blowers, modern compressors adaptable to either pressure or vacuum service. Selection charts give blower model, brake horsepower and rpm needed to provide specified air-moving capacities in cfm at required pressures in psig or vacuums in inches of mercury. Read Standard Corp.

148 Crawler Tractor — A series of assembly and parts photos are used in 16-pp Catalog MS-1100 to illustrate the concise text on design, engineering and operating features of company's 75-hp HD-11 diesel powered crawler tractor. Also contains specifications and shows equipment matched to this tractor to increase its versatility and job performance capabilities. Construction Machinery Div., Allis-Chalmers Mfg. Co.

149 Tubing Supports — Bulletin 656-G, 20-pp, discusses in detail company's tubing and piping support system. Explains how cutting in the field is eliminated by use of various adjustable and extension connectors and trough or ladder supports. Describes sharp bend connectors for tube raceway system, as well as L section for long spans to 20 ft, I section where heavier loading is required, and support hangers. P-W Industries, Inc.

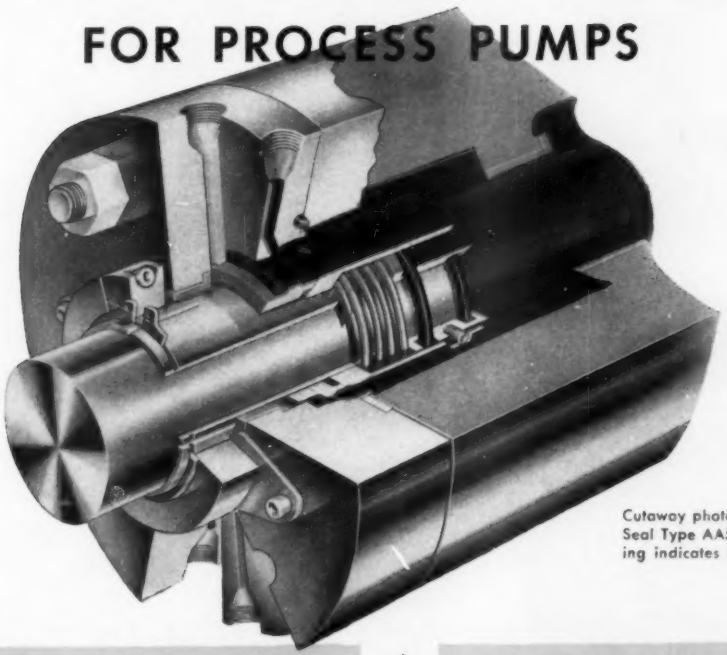
150 File For Tracings — A new way to store tracings and blue-prints is illustrated and described in this informative booklet. Design features of the inter-lock file, which consists of units which dovetail together forming files into a solid unit, are detailed and advantages are pointed out. Eugene Dietzgen Co.

151 Gas Turbine — Bulletin 142, 28 pp, describes a compact, 1130 bhp gas

NEW from GARLOCK...

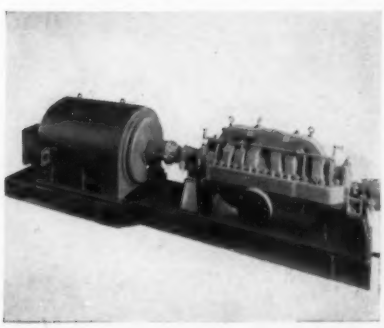
MECHANIPAK* SEALS

FOR PROCESS PUMPS



Cutaway photo of Garlock Unitary Seal Type AA51B-23. Yellow shading indicates liquid being sealed.

- **One Piece Assembly**
- **Quick, easy installation**
- **Pre-set at factory**
- **Maintenance-free life**



Typical boiler feed pump for which Garlock Unitary Seals are designed.

SAVE installation time, eliminate maintenance costs with Garlock's new Unitary Mechanipak Seals for process pumps!

The entire unit, including sleeve and gland, is furnished completely assembled. The seal is pre-set at the factory—no on-the-job adjustments are needed. The *external* lock and drive is readily accessible—eliminates set-screw drive.

Get all the facts today! Phone your Garlock representative or write for new Folder AD-151.

The Garlock Packing Company, Palmyra, New York

Sales Offices and Warehouses: Baltimore, Birmingham, Boston, Buffalo, Chicago, Cincinnati, Cleveland, Denver, Detroit, Houston, Los Angeles, New Orleans, New York City, Palmyra (N. Y.), Philadelphia, Pittsburgh, Portland (Oregon), Salt Lake City, San Francisco, St. Louis, Seattle, Spokane, Tulsa.

In Canada: The Garlock Packing Company of Canada Ltd., Toronto, Ont.

GARLOCK

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Now—"engineered" power

for switchgear-control —emergency lighting —auxiliary power

Compact, modern-design "power plants" engineered for specific applications! C & D PlastiCals and PlastiCells give you completely dependable power—*where power must not fail!*

PlastiCal—with lead-calcium grids for maximum life—is conservatively engineered for at least 25 years in full-float service. PlastiCell—with high-tensile alloy grids—has a projected life of 14 years in float service.

WITH BOTH PLASTICAL AND PLASTICELL YOU GET SUCH ADVANCED C & D DESIGN EXTRAS AS:

1. Extra-long life—exclusive design combines advantages of both suspended and supported plate construction.
2. Triple insulation—thick Fiberglas mat, microporous separators, and perforated Koroseal retainer.
3. Saftee-Vent—outstanding C & D development that prevents accidental battery explosions.
4. Crystal-clear plastic jars—heat-resistant and hermetically sealed.
5. Plastite Post Seals—for easier maintenance, and at the lowest lifetime cost.

Write for C & D Specification Bulletins:
CP-536 Rev. 1 on PlastiCal Batteries
CP-537 Rev. 1 on PlastiCell Batteries

C&D BATTERIES, INC.
of Conshohocken, Pa.
Industrial Batteries since 1906

SALES AND SERVICE OFFICES IN PRINCIPAL CITIES FROM COAST TO COAST

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turbine for industrial refining and processing applications. Important design and operation features are listed and full performance data, typical applications, dimensions and performance curves are given. Photos and drawings illustrate the text and a large cutaway view shows component features. Clark Bros. Co.

. . . Outstanding Among This Month's Catalogs

152 Tube Expanders, Cutters — Catalog 81, 32 pp, contains specifications of company's line of tube cutters and expanders for fire tube and water tube boilers, condensers-coolers, heat transfer units, refinery still tubes, others. Also gives necessary information on operating accessories. Many excellent demonstrations of product application are included among the 300 illustrations provided, as well as tables of sizes, ordering tips and distributors. The Gustav Wiedeke Co.

153 How Standards Are Made — This 20-pp booklet discusses the three ways in which standards become nationally accepted and approved as American Standards. Tells who makes these standards and why, and who uses them. Explains why the American Standards Association exists, how it guards the democratic processes through which American Standards are developed, and how it operates. American Standards Association.

154 Water, Waste Treatment — Catalog 905, 64 pp, features descriptive and engineering data on company's line of equipment for water, sewage and industrial waste treatment. Covers various types of screens, grinders for sewage screenings, traveling water screens, grit collectors and grit washers, settling tank equipment, and describes the Flocrol process for efficient clarification of water, sewage or trade wastes. Garbage grinders and auxiliary equipment described. The Jeffrey Mfg. Co.

155 Desuperheater — Bulletin 1024 describes capabilities and specifications of company's desuperheater which applies a new, but well-tested principle to reducing high steam temperatures. Operational features are described and illustrated with cutaway views, and complete specifications are included. Copes-Vulcan Div., Blaw-Knox Co.

You'll save time in ordering bulletins by using the Reader Service Cards on page 113. Of course we honor letterhead requests—but it takes us somewhat longer to handle them.

156 Hose Reels — Design and manufacture of hose reels for every use are highlighted in this 20-pp catalog. Prepared as a selection aid, catalog describes features of company's standard hose reels, as well as emphasizing facilities available for custom manufacturing to various specifications. Applications in fire fighting equipment, fuel delivery, industrial applications, LP-Gas delivery equipment, and others are cited. Clifford B. Hannay & Son, Inc.

Your boiler is very likely big enough to take advantage of famous Ljungstrom efficiency. Even boilers as small as 25,000 pounds of steam per hour have grown up to a Ljungstrom. Completely shop-assembled, this new unit arrives in one package, ready for installation. And you can expect these immediate results:

FUEL SAVINGS: Generally, ten percent or more. This alone means write-off is possible in approximately three years.

INCREASED BOILER OUTPUT: Preheated air makes higher combustion temperatures, which means higher steam producing capacity.

LESS MAINTENANCE: Better combustion reduces slag, makes for longer periods between overhaul. Cleaner stack gases. Less smoke nuisance.

EFFICIENT USE OF EVEN LOWER GRADE FUELS: Higher furnace temperatures allow effective burning of low grades.

Find out how the efficient, low-cost Package Ljungstrom Air Preheater can be applied to your steam-generating units. Write today to the Air Preheater Corporation. Free brochure on request.

This "package preheater" is for boilers in the 25,000 to 200,000 pound per hour range

The Package Ljungstrom operates on the continuous regenerative counter-flow principle. The heat-transfer surfaces on the rotor act as heat accumulators. As the rotor revolves, the heat is transferred from the waste gases to the incoming air.

The Air Preheater Corporation 60 East 42nd Street, New York 17, N. Y.

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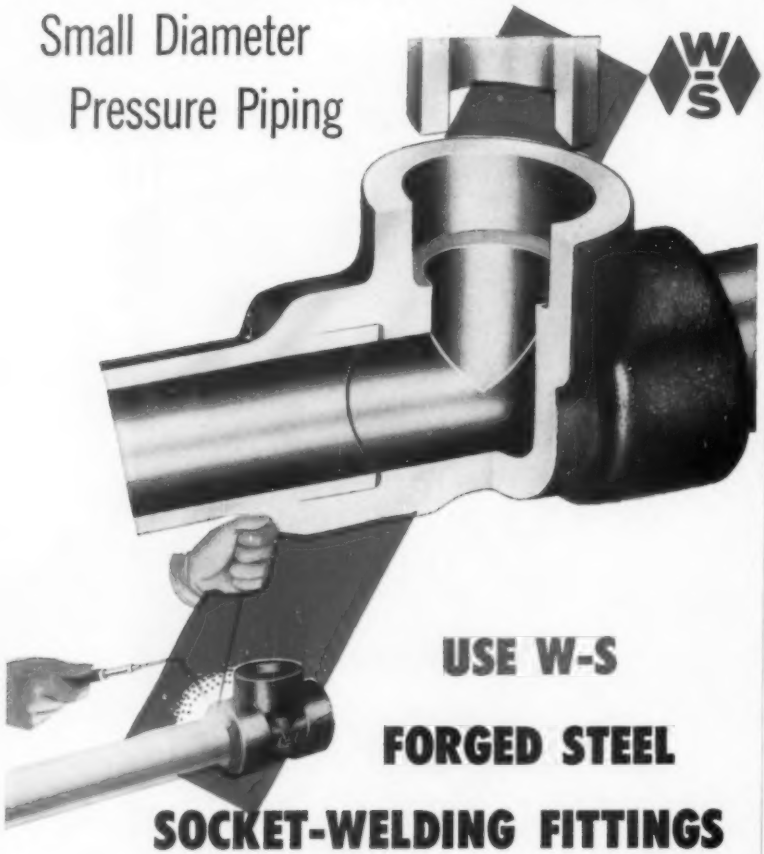
Here's the **EASY WAY TO WELD**
Small Diameter
Pressure Piping



USE W-S
FORGED STEEL
SOCKET-WELDING FITTINGS

In addition to providing high strength and toughness, W-S Forged Steel Socket-Welding Fittings are also easy to install. Deep sockets support and align the pipe for welding... eliminating the need for tack welding or special fixtures. No back-up ring is needed either. The fillet-weld is completely outside the pipe. Welding icicles just can't form inside the pipe. The result is a clean, tight welded joint that will readily resist high pressures and the stresses of shock and vibration. What's more, installation costs are lower.

W-S Socket-Welding Fittings are available in sizes ⅛" to 4" for schedule 40, 80, 160 and double-extra heavy pipe in carbon steel, stainless steels and alloy steels.

For complete information on the installation and operation advantages of W-S Forged Steel Socket-Welding Fittings, send today for Bulletin A-3-56.

W-S FITTINGS DIVISION
H. K. PORTER COMPANY, INC.
Roselle, New Jersey

For more data circle 521 on Post Card

157 Welding Fittings — Bulletin FB-502, 6 pp, describes briefly but completely company's line of carbon, alloy and stainless steel seamless welding fittings and forged steel flanges. Illustrated with photos, pictures various types and includes sizes. Tubular Products Div., The Babcock & Wilcox Co.

158 Tube Cutters —Bulletin 59 features precision made, air and electric driven tube cutters for plant, refinery and marine maintenance applications. Various types of cutters are described as to design, operation and applications. Tables show sizes available. Condenser cleaners, tube cleaners and midget tube cleaners are covered. Airetool Mfg. Co.

159 Super Pressure Tubing — Data Memorandum 22 describes super pressure tubing, designed for safe service at pressures up to 100,000 psi. Types of pressure tubing, sizes and production limits, tolerances, minimum bursting pressures, applications, pressure formulas and other information is included. Superior Tube Co.

160 Lighting, Ventilating Fixture — A single-fixture lighting and air diffusing unit is described in 8-pp Bulletin AD 6658. Tells how the fixture functions, gives advantages, and describes installation procedure. Suggested applications and descriptive data are included. Benjamin Electric Mfg. Co.

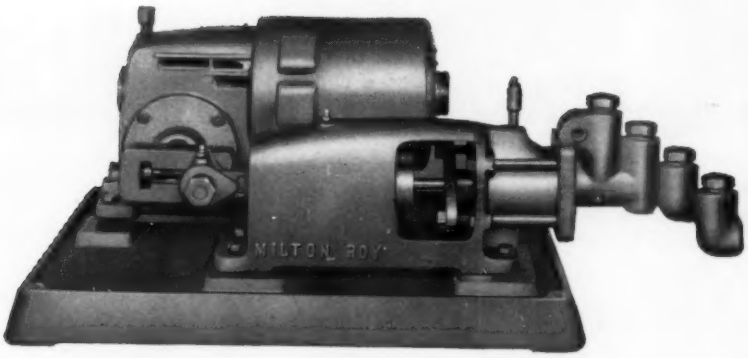
161 Mechanical Packings — Featured in 24-pp Catalog 56 are several recent packing developments including the multi-purpose Bel-Vee V-Ring packings, the long wearing criss-cross Braid packing series, twisted foil packings for oil and distillate temperatures to 1000 F, and an Inconel-wire reinforced plastic packing for valves handling superheated steam at temperatures up to 800 C. Packings for every industrial application are covered and a recommendation chart is included. The Belmont Packing & Rubber Co.

162 Vibration and Noise Control — Eight-pp Bulletin K7A shows by means of case histories how profits and production can be increased through vibration and noise control machinery mountings. Describes how company's mountings permit efficient plant layout, make possible utilization of all available space, prevent rejects. The Korfund Co., Inc.

163 Bellows Design Guides — Twenty-pp Catalog 155 contains helpful information on applications, design considerations, and standards for metallic bellows. Details on using bellows manufactured from various metals are included. Pictures, tables and charts supplement text. Flexonics Corp.

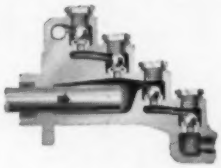
164 Product Guide — This illustrated 8-pp bulletin contains descriptive information on company's industrial products division and the products it manufactures, including power plant equipment, bridges, pressure vessels, process industry equipment and a wide variety of specialized products. Describes manufacturing facilities and includes production photos of manufacturing processes. Industrial Products Div., Maryland Shipbuilding & Drydock Co.

165 High Temp Grease — A stable, high-melt-point grease for bearings running at temperatures up to 250 F, or for sealed antifriction bearings used at normal temperatures is described in Bulletin 47. Included is a chart showing graphically the number of months or years this grease may be expected to lubricate at a given operating temperature. Sun Oil Co.



Standard Milton Roy Motor-Driven Controlled Volume Pump.

Exclusive Milton Roy
STEP-VALVE LIQUID END



Double ball checks, sloping passages and absence of air pockets assure highest possible volumetric efficiency. Should a solid particle lodge under one suction ball, for example, second suction ball will seat on discharge stroke, thereby preventing fluid from being pumped into suction piping.

Want to make your chemical metering more profitable?

Your operating and maintenance costs are lowest when you use Milton Roy Controlled Volume Pumps for metering process additives

Here are the features of Milton Roy Controlled Volume Pumps which contribute to their accuracy and dependability:

- Liquid ends can be constructed from a variety of materials for specific services.
- All parts are machined to close tolerances . . . base has web steel construction, provides rigidity required for perfect alignment.
- Cross-heads have large length-to-diameter ratio so that they fully support the plunger, increasing service life of packings.
- Rugged motors, gears, connecting rods and bearings easily withstand shock loads.

Accuracy of ± one percent increases end-product uniformity and reduces waste of metered chemicals. The result . . . lower production costs, more profitable operation.

Design and construction dependability provide long service life with minimum maintenance. The result . . . lower production costs, more profitable operation.

Milton Roy Controlled Volume Pumps serve equally well as flow controllers, ratio controllers, or final control elements . . . are available in simplex, duplex, and multiple liquid end types.

Whatever your chemical metering problem or requirement, a Milton Roy Controlled Volume Pump or Chemical Feed System will provide a trouble-free, economical solution. Capacities range from 3 milliliters per hour to 45 gpm . . . at pressures to 50,000 psi.

Write today for any of these bulletins:

"Controlled Volume Pumps in Process Instrumentation," Bulletin 1253.

"Controlled Volume Pumps in Industrial Water Treating," Bulletin 953.

"Controlled Volume Pumps in Paper Making," Bulletin 455.

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1300 E. Mermaid Lane
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Engineering Representatives in the United States, Canada, Mexico, Europe, Asia, South America and Africa

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CHEMICAL FEED SYSTEMS

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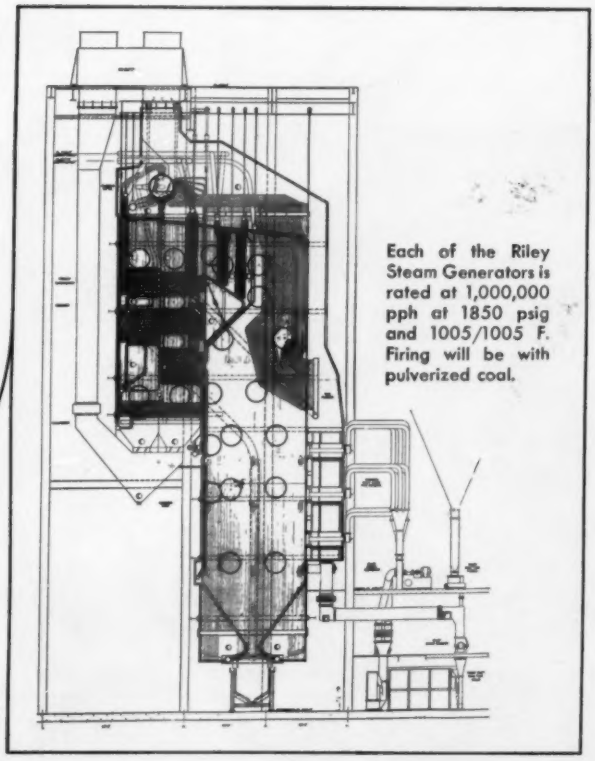
It's Vulcan Selective Sequence at New Albany Generating Station

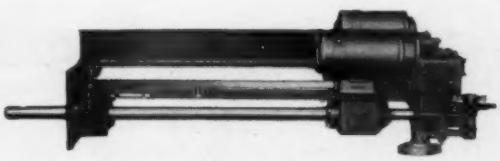


Each of the Riley Steam Generators is rated at 1,000,000 pph at 1850 psig and 1005/1005 F. Firing will be with pulverized coal.

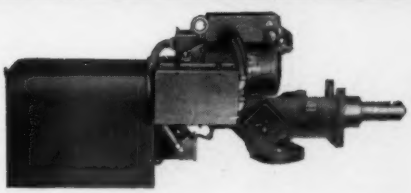
Boiler cleaning systems for Units 1 and 2 in the New Albany Station of Public Service Company of Indiana will be under Vulcan Selective-Sequence Control. Each of the two Riley Steam Generators will be equipped with a Vulcan Soot Blowing System which includes Long Retracts and Wall Deslaggers.

Selective-Sequence operation of the soot blowing system was chosen to give positive operation at proper intervals in precisely the sequence necessary for the most effective cleaning. Vulcan Long Retractable Soot Blowers with two motor operation assure maximum coverage with uniform cleaning of all surfaces. Vulcan Wall Deslaggers deliver maximum striking power to drive off slag, assuring high heat-transfer capacity and uniform control of superheat and reheat temperatures.

Modern soot blowing systems, with either automatic-sequential or selective-sequence control, can help keep your boilers operating at peak efficiency. Whether your boiler is power or process, large or small, investigate Vulcan Automatic Soot Blowing Systems for better cleaning results.



The Vulcan long retractable soot blowers will have electric drive and will blow with air.



Full cleaning action is assured by the high striking power of Vulcan Wall Deslaggers.

COPES-VULCAN DIVISION

BLAW-KNOX COMPANY

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50th Anniversary BLAW-KNOX 1906-1956

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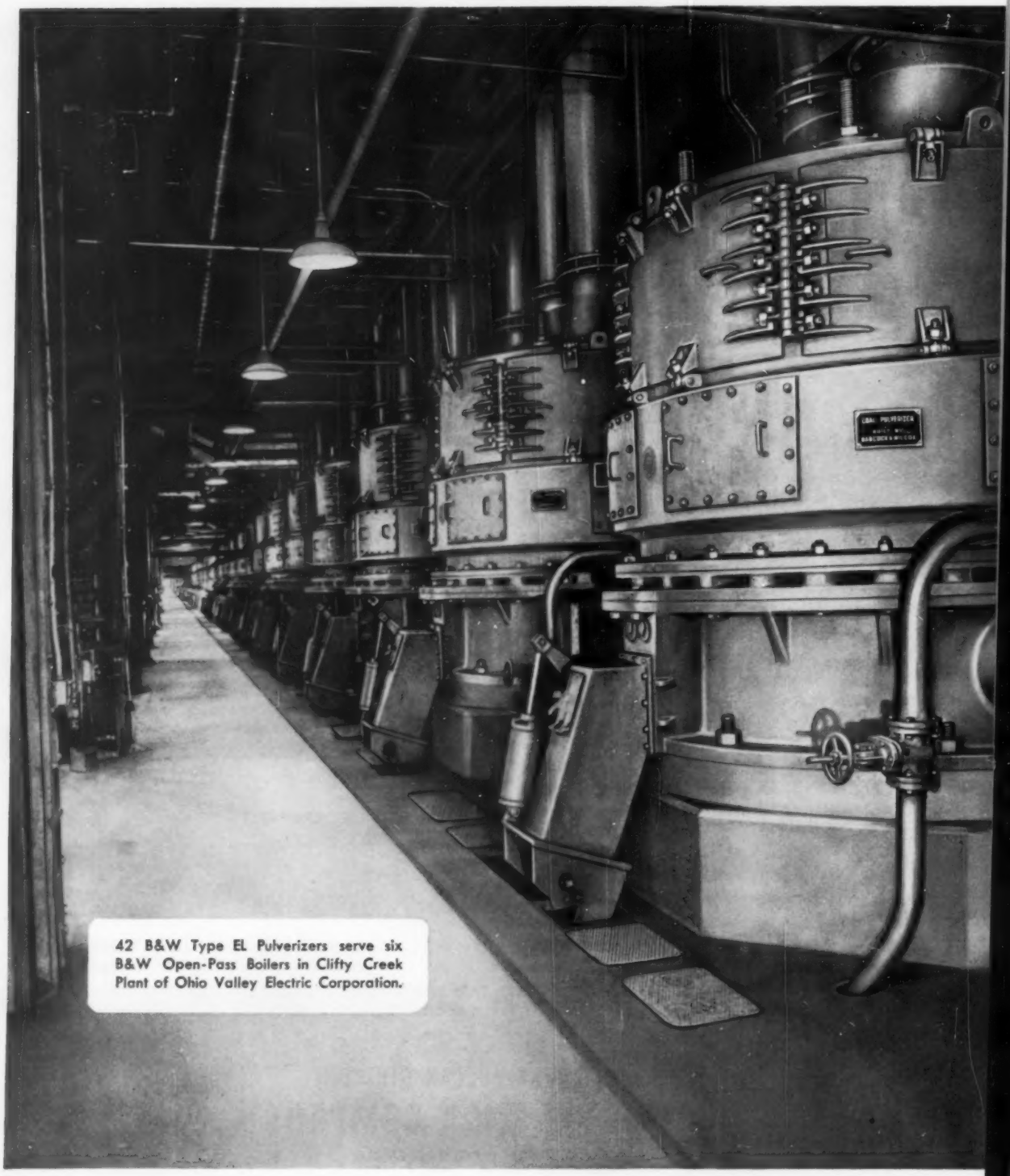
Have You Investigated

THE MODERN B&W



42 B&W Type EL Pulverizers serve six B&W Open-Pass Boilers in Clifty Creek Plant of Ohio Valley Electric Corporation.

DIRECT-FIRING SYSTEM?

A Compact, Space-Saving Package of Efficient Grinding Power

More power and capacity in a compact arrangement . . . long-range dependability . . . reduced operating cost — these are the measurable results of continuous, intensive development of the modern B&W Pulverizer. It has established an outstanding production and efficiency record in thousands of commercial installations. Here are some reasons why:

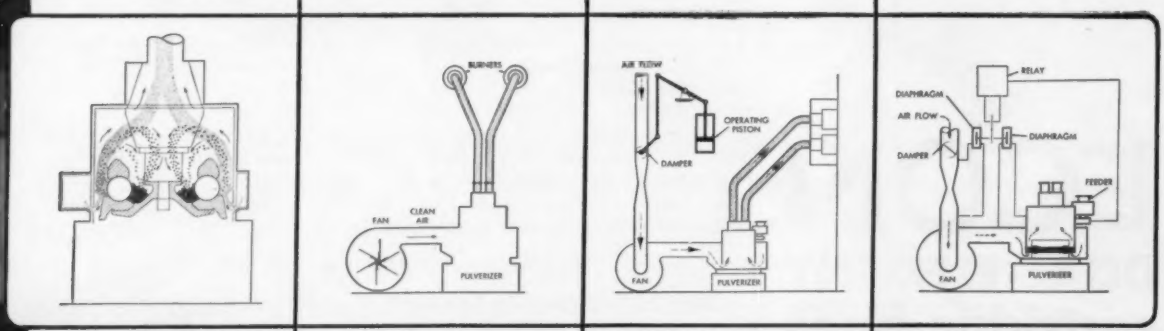
Continuous High Fineness Over Entire Service Life: Efficient combustion requires high fineness at all times. The high circulating load of the B&W Pulverizer permits efficient and dependable classification of product, so that only material of proper fineness leaves the unit. In addition, its slow-speed, spring-loaded ball bearing grinding elements maintain proper grinding contact throughout their service life.

Handles Wide Variety of Low Grade and Wet Coal: Regardless of the coal's grade or whether it's dry or soaking wet, the B&W Pulverizer's unique and exclusive recirculation of fuel through heated air assures efficient grinding . . . eliminates shutdown, capacity loss, or special attention from operators.

Simplicity of Arrangement and Reduced Maintenance: Accessibility for all normal maintenance makes it simple, quick, safe and low-cost. Adjustments are easily made while the unit is in operation. Using only clean primary air supplied under pressure, fan maintenance is substantially reduced and fuel piping is greatly simplified. Also, with the pulverizer acting as its own distributor, no special distributing devices are needed. Grinding elements are of special alloy material. They last two years or more on eastern coals and at least a year on midwestern coals.

Adaptable to All Types of Automatic Controls: Because it features "one point contact with the boiler," operation of the B&W Pulverizer is simple. The boiler's automatic combustion control is connected to the pulverizer at only one point—the damper in the primary-air duct. The pulverizer's own control system regulates all other functions, such as maintenance of proper fuel-air ratio and operating temperature.

SEND FOR DATA. For full information about the B&W Type EL Pulverizer and Pulverized-Fuel Firing Systems, write: The Babcock & Wilcox Company, 161 E. 42nd Street, New York 17, N. Y.



COAL RECIRCULATION — this means high fineness, aids drying.

PRESSURE SYSTEM — this eliminates fan wear, simplifies piping.

AIR CONTROL—this means one, simple control contact point.

MILL LEVEL CONTROL — this automatically adjusts fuel-feed.

BABCOCK & WILCOX

BOILER DIVISION

G-766

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IT THINKS with a difference that means extra protection!

ECON-ALLOY makes the Difference!
When current overload is continued beyond the safe and pre-determined time, exclusive Econ-Alloy breaks the circuit by changing directly from solid to liquid. The usual plastic stage is eliminated, insuring faster, more accurate protection against overloads and shorts.
CIRCUIT
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• End Needless Fuse Blows
• Eliminate Down Time
* Fast Short Circuit Protection

With the exclusive, *different* Econ-Alloy thermo element acting as the "brain" of the ECON Dual-Element Fuse, you get *double* protection: accurate, "timed" protection against overloads (up to 500%)—and *instant* breaking action on shorts.

Economy Dual-Element Fuses are specially engineered for motor, branch and feeder circuits—save time and money where you have frequent power surges, or the risk of high fluctuation in load.

Available in knife and ferrule types: 0 to 600 amperes; 250 and 600 volts. Approved by Underwriters' Laboratories, Inc.

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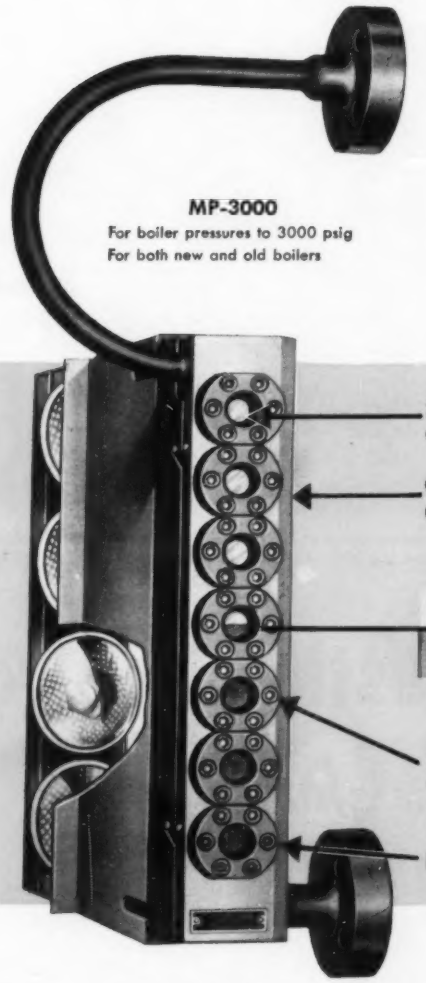
MORE THAN 950 DIAMOND MULTI-PORT GAUGES

In use and on order for over 240 Central Station Generating Plants



MP-3000
For boiler pressures to 3000 psig
For both new and old boilers

SMALL ROUND PORTS INSTEAD OF LONG GLASS AND MICA STRIPS

GAUGE NEVER REMOVED FROM BOILER FOR GASKET CHANGES OR OTHER NORMAL MAINTENANCE

STEAM SHOWS RED

WATER SHOWS GREEN

COMPLETE PORT CHANGE REQUIRES ONLY ABOUT 15 MINUTES

EACH PORT THERMALLY INDEPENDENT

Because the Diamond Multi-Port solves the problems inherent in water level gauges on boilers operating at high temperatures and pressures, it has had rapid and wide acceptance. In addition to the 950 for central station generating plants, more than 100 have been sold to industrial power plants.

Advantages of the Multi-Port are many. In addition to those shown above, it has maximum thermal stability for rapid starting . . . "Hi-Lite" illuminator for improved readability . . . welded construction for permanent tightness . . . end stems can be furnished instead of flanges . . . startling reductions in maintenance costs.

Write for Bulletin 1174AB for more information.

7625

Diamond

POWER SPECIALTY CORP.

LANCASTER, OHIO • DIAMOND SPECIALTY LIMITED — *Windsor, Ontario*

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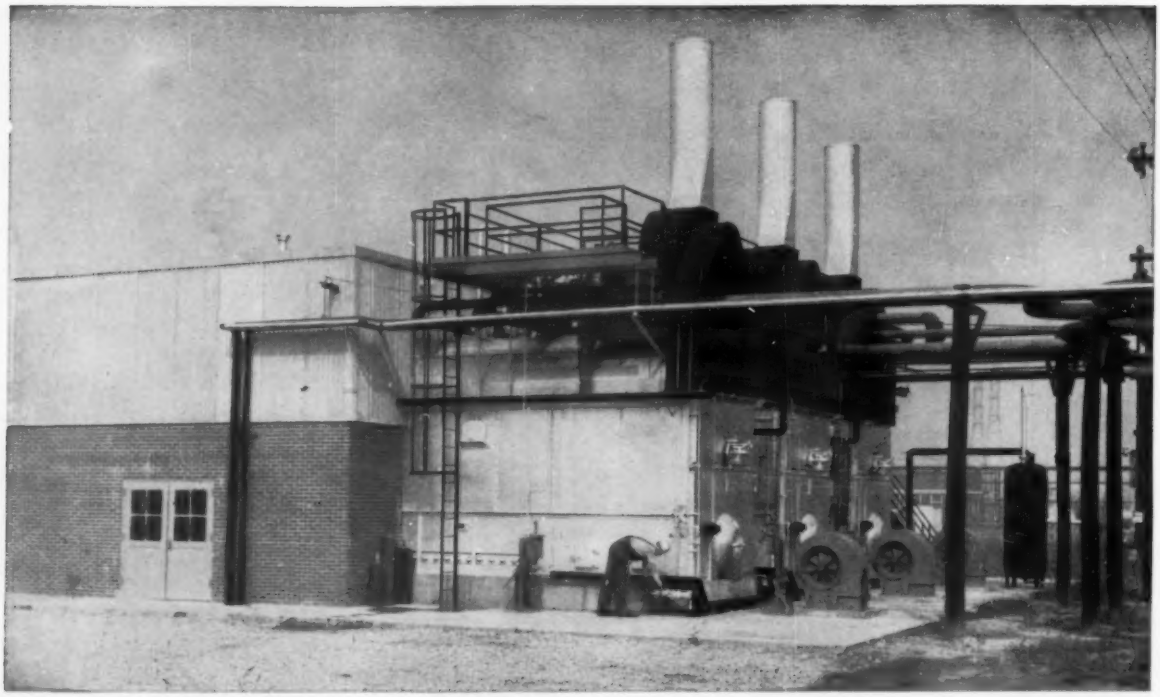


COMBUSTION CONTROLS GO OUTDOORS to help cut steam costs at American Synthetic Rubber Corporation's new packaged boiler plant near Louisville, Kentucky. The three 27,000 lbs./hr. gas or oil fired boilers operating at 175 psi generate steam for heating and processing.

"Big Station" Combustion Controls

Metering-Type Republic Control System Saves Fuel, Enables Boilers to Handle Fast Load Changes Quickly and Smoothly at American Synthetic Rubber Corporation

Peak combustion efficiency plus fast control of widely varying loads—these were combustion control requirements at American Synthetic Rubber Corporation's new packaged boiler plant near Louisville, Kentucky. To meet them, a metering-type combustion control system was specified instead of the "off-on" system usually furnished with packaged boilers. This system contains all of the basic control elements found in large installations and has all of the operating refinements common to large plants.

Is this metering-type control system worth its premium price? Flue gas tests made at various ratings conclusively answer the question with an emphatic YES. Combustion efficiency exceeds what similar packaged installations are delivering — and smoother operation is preventing chain-of-event troubles that frequently are caused by improper boiler operation. American Synthetic expects the controls to pay their extra cost in just a few years through fuel savings alone.

REPUBLIC FLOW METERS CO.

HOW METERING SYSTEM AT AMERICAN SYNTHETIC SAVES FUEL

Unlike most packaged boiler control systems, the Republic Combustion Control System at American Synthetic continuously measures both fuel and air inputs. Changes in fuel pressure, for example, which change the rate of fuel feed are detected immediately and automatically compensated for. Proper fuel-air ratio is maintained automatically at all ratings for maximum combustion efficiency.

Fast load changes are common in the plant with fluctuations varying as much as 8,000 lbs./hr. Rapid control response with Republic's dash-pot stabilization which prevents "hunting" enables boilers to meet new steam demands quickly and smoothly. Steam pressure and draft are held constant even during changing loads by the controls.

CONTROL SYSTEM CHANGES WITH FUEL

On oil firing, the controls operate on a steam flow-air correction system. For safety on gas firing, the controls are transferred to an air flow-gas flow correction arrangement which prevents over-firing in case air to the boilers is limited or blocked for any reason.

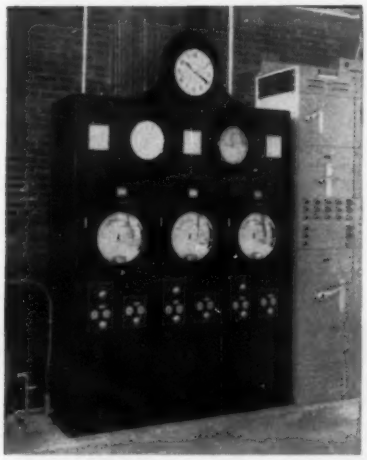
OPERATORS ARE ENTHUSIASTIC

The automatic correction feature of the Republic Controls eliminates time-consuming gas analysis and adjustments which would be necessary periodically with other types of controls. Correct operation of the boilers is easier, surer.

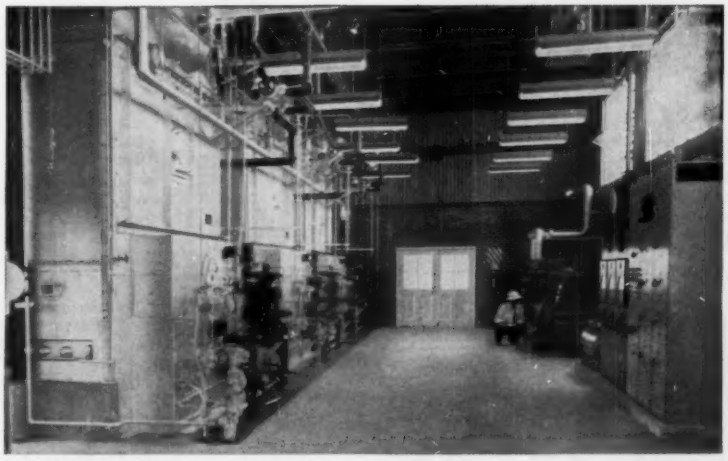
IF YOU ARE PLANNING ON INSTALLING PACKAGED BOILERS, find out how metering-type combustion control by Republic can improve efficiency, cut fuel costs and make operation simpler and easier. Contact your nearest Republic representative.

IF YOU ARE PLANNING *ANY* BOILER PLANT—any size, type or method of fuel firing — you can be sure of maximum efficiency with a Republic Combustion Control System engineered to exactly meet your needs. Write us when your problem is combustion control.

Pay Off for Packaged Boiler Plant



CENTRALIZED instrument and combustion controls on this Republic panel make checking and manual operation convenient and easy.



LOOKS EFFICIENT . . . AND IS. Interior view of the boilerhouse. All three boilers can be operated together or separately by means of control panel at right.

2240 Diversey Parkway • Chicago 47, Illinois

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CONSTRUCTION NEWS

Riverside, Calif. — California Electric Power Co, 3771 W Eighth St, has made application to the California Public Utilities Commission for permission to arrange financing in the amount of $8,000,000, proceeds of which are to be used in part to pay back short term loans of $4,250,000 and the balance to be used for company expansion currently under way. Company plans to borrow additional funds before the end of the year to cover cost of expansion of generating facilities and distribution lines.

Windsor, Conn. — Combustion Engineering, Inc, 208 Madison Ave, New York, N. Y., has work under way on a new nuclear engineering and development laboratory where it has been authorized by the Atomic Energy Commission to construct a prototype reactor plant for use in small submarines. Construction of the prototype will permit solution of technical problems prior to installation of similar reactor plants in operating submarines. Estimated cost of construction of new unit will be $10,000,000.

St. Petersburg, Fla. — Florida Power Corp, 101 S Fifth St, has selected a plant site on Tampa Bay where it plans to erect a new steam-electric generating station. Initial capacity of new generating facility will be 120,000 kw. New plant will be equipped with port facilities for unloading and storage of fuel oil to operate the new unit. Plant when completed will cost in excess of $20,000,000 and is part of 2½ year expansion program of more than $100,000,000 announced by the company earlier this year.

Brunswick, Ga. — Georgia Power Co, Electric & Gas Bldg, Atlanta, Ga., has announced plans of a major expansion program at its McManus steam-electric generating plant, near here. Work will include installation of a new steam-electric generating unit with an initial capacity of 75,000 kw at an estimated cost in excess of $13,000,000. When completed, unit will treble capacity of existing plant. Construction is scheduled to begin in early 1957 for completion in 1959.

Decatur, Ill. — The Illinois Power Co, Decatur, and the Central Illinois Light Co of Peoria, Ill., have announced agreement on the exchange of electric properties serving 21 communities to become effective as of Jan 1, 1957, subject to approval of the Illinois Commerce Commission. Exchange includes transmission lines furnishing power for resale in 5 communities and a 70 mile right of way between Peoria and Springfield to be transferred to the Central Illinois Light Co system.

Peoria, Ill. — Central Illinois Light Co is arranging financing with the proposed sale of a stock issue in the amount of $8,000,000, proceeds of which will be used to pay for company's construction program now under way. Company's plans for an expenditure of about $19,200,000 this year are well under way and utility proposes to spend an additional $25,000,000 during 1957 and 1958 for increased generating capacity, transmission lines and other miscellaneous work.

Gary, Ind. — Northern Indiana Public Service Co, 5265 Hohman St, Hammond, Ind., has authorized plans for company expansion of local plant here. Plans call for two additional generating units each with a capacity of 138,000 kw in addition to present installation now under way. The plant when completed will occupy about 83,000 sq ft of a 100-acre site near Buffington Harbor and will employ about 150 men when in production. Three units will bring station's total net generating capacity to 390,000 kw, largest single source of power in company's system. Cost of three unit plant with buildings and monument to approximate an investment of $60,000,000.

Sullivan, Ind. — Indiana and Michigan Electric Co, 220 W Colfax Ave, South Bend, Ind., subsidiary of the American Gas & Electric Co, 30 Church St, New York, N. Y., has announced plans for the construction of a new steam-electric power plant, with an initial capacity of 450,000 kw. Provision is being made for the eventual doubling of capacity. New unit will burn about 1,300,000 tons of coal as fuel, supplied by the Ayrshire Collieries Corp, under a 15 year contract. Initial unit is expected to be placed on line in early 1959. Cost of new generating facility will represent investment of $58,000,000.

Dodge City, Kan. — Western Light & Telephone Co, Huron Bldg, Kansas City, Kan., has authorized a major expansion program and has plans under way on the construction of a new brick and masonry, semi-enclosed type structure, 55 ft in length, to house a new steam-electric generating unit with an initial capacity of 20,000 kw, along with necessary appurtenances, boilers and auxiliary equipment. The Austin Building Co, 1000 Singleton Rd, Dallas, Tex., has been awarded the contract at an estimated cost with equipment of $3,000,000.

Holyoke, Mass. — Providence Hospital, 679 Dwight St, Holyoke, Mass., has plans under consideration for installation of new boiler and boiler house facilities including hospital laundry. Eggers & Higgins, 100 E 42nd St, New York, N. Y., are the architects, and cost of building and appurtenances reported to be in excess of $4,500,000.

Sidney, Mont. — Montana-Dakota Utilities Co, with headquarters in Minneapolis, Minn., has plans under consideration for expansion of company facilities and has authorized the purchase of a new steam turbine generator with an initial capacity of 44,000 kw. When completed, generating facility will be installed at new plant near here. Unit under construction at General Electric Company's Lynn, Mass., plant is designed to operate on North Dakota lignite as fuel, along with gas as a standby fuel. New facility will cost $8,000,000.

Columbus, Neb. — Nebraska Public Power System has plans under consideration for major expansion of company substation and distribution system involving an expenditure of approximately $2,000,000. Expenditure will be apportioned for new and improved construction as follows: Loup City substation $250,000; Neligh substation $100,000; Albion substation $250,000; Winnebago substation $400,000; and installations at Oakland and North Platte substation $1,000,000. P. E. Hampton is in charge of engineering at the various projects.

Indian Point, N. Y. — Consolidated Edison Co, 4 Irving Place, New York, N. Y., has authorized a contract to the Foster Wheeler Corp, 165 Broadway, New York, N. Y., for the design and construction of an oil-fired superheater for company's new atomic plant now under construction on the Hudson River, near here. Facility will be used to lower production costs by superheating steam as it comes from the atomic reactor from 447 F to 1000 F before it is piped to the turbine generator. Work on new plant is proceeding as planned and new superheater installation will cost $3,250,000.

Niagara Falls, New York — Niagara Mohawk Power Corp has announced plans for a major expansion program of company facilities here, to exceed an investment involving better than $75,000,000. Expansion will include the installation of two steam generating units each with a capacity of 200,000 kw. Location of the new installation will be in the western part of the state and as yet has not been announced. Work on the two units will begin at once and are expected to be placed in operation the latter part of 1959. When they are completed company's generating capability will amount to 3,550,000 kw, of which 2,665,000 is steam generated.

Raleigh, N. C. — Carolina Power & Light Co, 336 Fayetteville St, has authorized financing in the amount of $13,000,000 through sale of 500,000 shares of stock, proceeds of which will be used in part to pay off short term bank loans and help finance company's 1956-1957 new construction program. 1956-57 construction program, expected to cost some $42,000,000, will include property additions, increased generating facilities, transmission lines and general improvements of company facilities.

Beaumont, Texas. — Gulf States Utilities Co, 362 Liberty Ave, has been granted permission by the Federal Power Commission to arrange financing in the amount of $15,000,000, proceeds of which will be used in connection with current construction program and expansion of generating and distributing facilities of company in Texas and Louisiana.

Richmond, Virginia — Virginia Electric & Power Co has announced plans for financing in the amount of $20,000,000 and has filed a grant of permission with the Securities and Exchange Commission. Proceeds from the sale of bonds will be used to help finance company's 1956 construction program reported to be in excess of $50,000,000. Portion of proceeds will be used in connection with current expansion program, covering additional generating facilities, transmission lines and other operational facilities.

Institute, W. Va. — B. F. Goodrich Chemical Co, 100 W Broadway, Louisville, Ky., has announced plans for the construction of new steam power plant. Plant will be designed and built to supply 100,000 lb of steam per hr for Goodrich-Gulf's synthetic rubber operations here. The Girdler Co, Division of National Cylinder Gas Co, has been awarded the construction contract. Installation scheduled to be in operation by mid-1957 reported to cost approximately $1,500,000.

Instruments for Load Analysis

2 New Ranges for General Electric Inkless Recorder Help You Get More Accurate Checks of Electrical Loads

FOR IMPROVED LOAD ANALYSIS, General Electric's CF-7 hook-on recorder now has a total of nine ranges, greatly increasing the flexibility of this already versatile inkless recorder. Easy and accurate recordings can now be made over ranges of 15/30/75/150/300/750 amperes a.c. and 150/300/750 volts a.c. making the instrument suitable for a wide variety of applications.

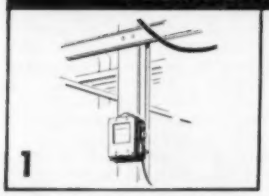
SIMPLE TO USE, the CF-7 measures either current or voltage without interrupting service. The current transformer is merely hooked onto the line. Molded in butyl, the hook-on transformer is ASA rated up to 8700 volts. For operating safety, the transformer secondary is short-circuit protected.

LIGHTWEIGHT AND PORTABLE, the CF-7 can be installed for recording either current or voltage in only four simple steps. (See explanation below.) Once installed, the recorder requires little servicing other than replacing record rolls.

3 WAYS BETTER for checking growing commercial and industrial loads, the CF-7 provides fast, convenient hook-on installation, inkless recording, plus the ability to operate continuously for 30 days without attendance.

SEE FOR YOURSELF how the General Electric hook-on recorder can help solve coming electrical load problems. Write Section 582-16, General Electric Co., Schenectady 5, N. Y., and ask for bulletin GEA-6104, or contact your nearest G-E Apparatus Sales Office.

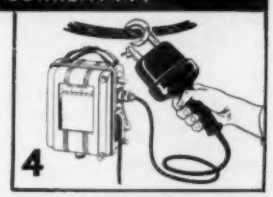
FOUR-STEP INSTALLATION IS FAST AND EASY—FOR RECORDING CURRENT . . .



MOUNT RECORDER on pole or other convenient location. Connect recorder to either 120- or 240-volt power supply (50 or 60 cycles).

CONNECT TRANSFORMER LEAD to special socket on the side of the recorder. Extension leads are available in 10- and 50-foot lengths.

SELECT PROPER RANGE by setting selector switch on the side of the recorder for any one of six current ranges—15, 30, 75, 150, 300, 750 amperes.



HOOK CURRENT TRANSFORMER on the conductor which is to be checked. Butyl-molded transformer is ASA rated up to 8700 volts for safety.

GENERAL ELECTRIC

EQUIPMENT NEWS

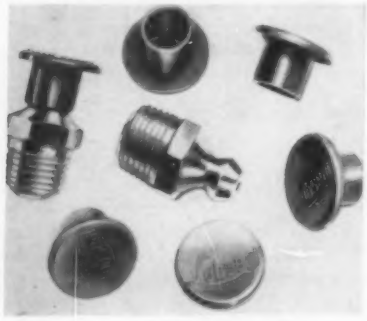
Described on these pages are new and improved products. Use Reader Service Cards on pages 113–114 to ask for more information on them. Just circle the item numbers of all the products in which you are interested.

1—WATER GAGE provides two color-readings

Bright two-color red and green readings and greatly reduced maintenance are among features announced for the Yarway Color-Port Water Gage. It is designed for high pressure boilers up to 3300 psi. In the port-type openings, water shows green, steam shows red. Thus a full gage is all green, and empty gage all red. Individual cover glass assemblies permit servicing of the gage in place, without removal from boiler. Large diameter port openings give increased visibility and a variety of mirror arrangements serve to bring the brilliantly lighted, head-on view of the gage face to convenient operating floor locations. Yarnall-Waring Co.

2—PLASTIC CAPS snap over grease fittings

A practical, economical solution to the problem of maintaining clean, dirt-free grease fittings between lubrications is offered in the form of Lubseals — plastic caps which snap over any standard



grease fitting to keep particles of dust, grit and abrasives from collecting on fittings, and later being injected into bearings during greasing. Available in 4 bright colors which effectively "flag" hard to find grease fittings, eliminating skips and grease starved bearings, Lubseals are priced at about $7.50 a thousand. The distinctive colors may be used to inexpensively color-code lubrication systems on machines where some fittings require more frequent greasing. They also offer a fast way of masking grease fittings for spray painting of machinery. Wilson Plastics, Inc.

3—STEAM COILS with special tilted feature

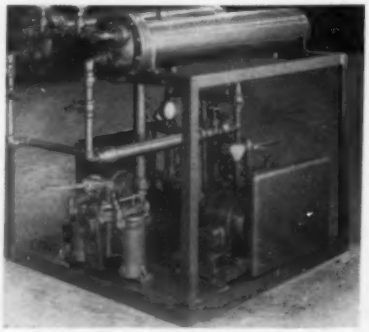
This line of heavy duty, distributor type steam coils has a special tilted feature to assure drainage of condensate, whether used for vertical or horizontal air flow. Cover pieces at header and stub ends are perforated to allow passage of measured amount of by-pass air, resulting in increased coil capacity. Coils are pitched in casing to assure full drainage to condensate outlet, and designed so that every square foot of face area produces equal heating capacity on full or modulated steam supply. Coils are available with inlet and outlet on same end or on opposite ends, and can be supplied with gas tight casing. They have tubes of ⅝ in. OD by 0.035 in. wall copper. Stainless steel coils are available. Aluminum fins, tubes are high tensile brazed to headers, and casings are 14-gage steel. Sizes range from 12 in. to 48 in. face height and from 24 to 120 in. width. Rempe Co.

4—SKULL CAP protects heads in close quarter jobs

The No. 75 Skull Cap is announced for use in close quarters, where head bumps and lacerations are a problem. An elastic band worn low on the back of the neck, adjusts cap to any head. Light weight and comfortable, the skull cap has a padded removable sweatband. It is said to be particularly adaptable for use in grease pits, under conveyors, and operations where there is low head room. The Boyer-Campbell Co.

5—HEATER PUMP SETS for heavy fuel oils

Packaged combinations for preheating, straining and pumping heavy No. 5, 6 and Bunker C fuel oils are available in duplex or single assemblies. Each set is a self-contained unit, ready for operation as soon as connections are made to fuel line and electrical service. Designed for use with all burners using heavy oil, pump and preheater assemblies come in 4 standard sizes: from 100 to 700 gph capacities. Equipment for single assemblies includes oil preheater, duplex oil strainer, fuel pump, motor, push-button magnetic starter, pressure gage reading from 0 to 160 psi, ¾ in. relief valve, sheaves and belts, fan-type temperature gage, check valve and gate valve. Components are assembled and mounted on a steel base plate and frame. Aquastat and circulator for hot water or steam solenoid for steam are also furnished. For duplex assemblies, two sets of most of the components are provided. York-Shipley, Inc.



6—PH METER is pocket-size, easy to operate

The Pocket pH Meter is a battery operated instrument having a range of 2 to 12 pH. The single electrode combines

both reference and glass electrodes. The instrument also has a "memory" dial for use in standardizing. It operates from simple batteries similar to those used in flashlights. Scientific Instruments Div., Beckman Instruments, Inc.

7—ANION EXCHANGER is high capacity, porous type

Nalcite SBR, Porous Grade, is announced as a high capacity strong base anion exchanger. It is expected to find use in water demineralization as well as certain processing applications. The spherical particles have exceptional physical strength, says manufacturer, yet they exhibit characteristics of flexibility. Particle size has been selected to obtain best hydraulic characteristics which, it is pointed out, is important in handling low density ion exchange resins. National Aluminate Corp.

8—SAFETY SHUTOFF needs no sensing element

This impulse monitor is announced as a shutoff and alarm for automatically controlled processes; it requires no sensing elements or electronic circuitry. It is designed to provide a complete, safe shutdown of process and sound an alarm in event of controller failure in the "on" period; and an alarm in event of abnormal "off" period or fusing of power contactor. Although present models are designed primarily for heat treating furnaces, company says principle can be applied to any process involving heat, pressure or flow where the control system uses an on-off, two position or pulsing type of control mode and where input is of reasonably uniform duration.

The device operates independently of furnace temperatures. Operation is a direct function of the signal from automatic controller. According to manufacturer, it continually monitors input

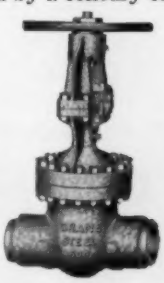
No repairs, no maintenance for these Crane valves —after 12 years on feed-water service

The day these Crane steel valves were installed 12 years ago, they started saving money for the Neches Butane Products Company's butadiene plant in Texas.

Not once have these 8-inch No. 76½ XR steel gate valves required repairs—not once have they needed maintenance . . . and they've been on hard, continuous service on lines to boiler feed pumps in this 3 million pound-per-hour steam plant.

There's more than meets the eye to valve service like this. From the outside, the average person wouldn't know the difference between Crane valves and others of the same type. That's why those who know valves investigate the *inside* quality before they specify. When the valves are Crane, they don't have to look far to find this quality—quality in materials, engineering and construction that literally means the difference between long, cost-free performance and expensive, aggravating, down-time maintenance.

Don't take chances with your all-important valves. Specify Crane, and make *sure* of getting service you can depend on—with the world's most complete line to select from, backed by a century of unparalleled experience in serving industry.



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to controlled process, and acts instantly to shut down process and sound an alarm when abnormal conditions arise. It can be wired to operate an external alarm circuit or to signal failure over telephone lines or protective agency equipment. A toggle switch permits bypassing monitor during initial process rise and during erratic charging of process. Monitor must be reset manually after each shutdown, permitting check on cause of failure. Priced comparably to existing safety devices, monitor is reported effective on electric, gas or oil furnaces. Three models are available. Catalog 256 provides further details. Damol Corp.

9—PRIMING SOLUTION for use with coal tar coatings

TC Primecoat is announced as a priming solution developed especially for use with company's coal tar protective coatings. It is designed to give users a primer that is compatible with the coal-tar-pitch base used in these protective materials, it is pointed out. TC Primecoat is available in 1-gal cans, packed 2 gal to the carton. According to company, application coverage is 400 sq ft per gallon. The Tapecoat Co.

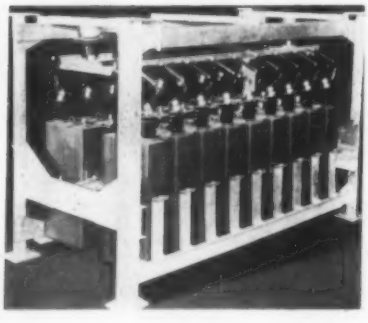
10—PVC EXPANSION JOINT for rigidly fixed piping

This slip type expansion joint is made of unplasticized polyvinyl chloride in 1-, 2-, and 3-in. sizes; it may be used with piping of smaller diameters by employing reducing bushings. All sizes allow an expansion of 3¾ in. The new unit is designed for use with rigidly fixed PVC piping subjected to thermal cycles. It has a Neoprene O-ring packing and is declared suitable for a wide range of corrosive services. When made of normal impact PVC, the 1-in. size has a pressure rating of 205 psi at 75 F, and of 120 psi at 140 F. Tube Turns Plastics, Inc.

11—CAPACITOR BLOCKS for use with 50 kvar units

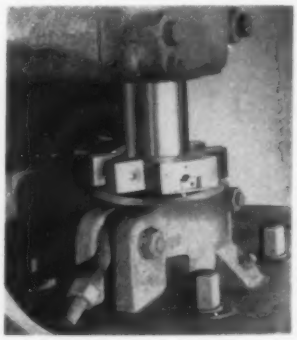
Factory-assembled capacitor blocks, for use with 50-kvar units in open type banks at transmission, subtransmission and distribution voltages, are said to reduce equipment costs, decrease field installation charges, and require only about half the substation area used by blocks for 25-kvar units. The blocks are also claimed to facilitate changes in bank size and voltage rating as varying system conditions require, and to provide flexibility for relocation.

A standard block consists of two rows of 50-kvar capacitor units, 5-kv or 8.7-kv class, connected in parallel and mounted in a galvanized steel frame of standardized dimensions. Ready for installation with similar equipments, available blocks have capacities ranging from 400 to 1200 kvar. Individual fuses in bus-mounted cutouts protect the units. Line Material Co.



12—REFACING TOOL prepares a smooth gasket surface

The BJ Stuffingbox Refacing Tool is designed to prepare pump stuffingboxes for mechanical seals. It prepares a smooth gasket surface on stuffingbox end for proper mechanical seal performance. Consisting of a tool bit and holder,



tool machines stuffingbox end at right angles to shaft axis. Bit holder mounts on shaft with tool bit against stuffingbox end. The bit is adjusted to bore and is worked outward by turning shaft with a Stillson or strap wrench. According to company, a mechanical seal, properly installed eliminates stuffingbox repacking and maintenance and solves problems of leakage on most pumping services. Tool is chrome plated and is shipped with wrenches and two extra tool bits. It is available in three standard sizes — they range from ¾ to 3 in. Byron Jackson Pumps, Inc.

13—CONTROLLER-RECORDER for pressure and temperature

Type 57 Pneumatic Recording Controller controls and records both pressure and temperature. Available models have either 9 or 12 in. spring or electric driven charts and on-off, duplex on-off or 1–100 per cent proportional action. Pressure ranges from 0–5 to 0–5000 psi (0–25,000 psi for 12 in. single pen only) and temperature range is from −350 to 1200 F. Type 58 Recorder records pressure and temperature, both in the same ranges as Type 57 recording controller. Models of Type 58 Recorder come with either 6-, 9-, or 12-in. charts, are either spring wound or electric driven, and are equipped with from 1 to 4 recording pens. A. W. Cash Co.

14—MOTOR incorporates internal dry fluid coupling

The Flexi-Shaft Motor utilizes a fluid-drive principle, that of using steel shot instead of a true fluid. The dry fluid coupling is mounted inside the motor's frame and the entire unit supplied as a single-frame power "package." These motors are further available in the same power packages as company's true fluid, Fluid-Shaft units. Combinations with magnetic brakes and gear reducers can be supplied. Primary features claimed are smooth load acceleration, protection against equipment jamming, and ability to start heavy loads on lower, actual operating horsepower.

The dry-fluid coupling is announced as an adaptation of the Dodge Flexidyne. Its operating principle is based on centrifugal force throwing the steel shot to the perimeter of the housing which, in turn, is keyed to the load and accelerates as the rotor becomes "imbedded" in the tightly-packed shot. Flexi-Shaft Motors are produced in ratings from ½ through 15 hp. Reuland Electric Co.

15—DIAPHRAGM VALVES with new topworks, redesigned body

Topworks of the Super 70 Series Diaphragm Control Valves feature a new moulded diaphragm for uniform thrust over full valve travel, pressed steel cases, and a precision-calibrated single spring. Entire topworks is iridited and cadmium plated for corrosion resistance, and is available in direct or reverse acting styles, in four sizes. Valve bodies have streamlined flow contours, top and bottom guided inner valves, all-metal float ring seal designed to provide self-actuating closure and tighten with application of pressure, forged clamp ring that allows yoke orientation to any position, and bolted stuffing box with stainless steel followers. Valve bodies come in three styles — single port, double port, and split body for use in erosive or corrosive fluid service where easy removability of valve seat is desirable. Catalog 70-11 gives more details on these valves. Black, Sivalls & Bryson, Inc.

16—LEVEL TAPE SQUARE is versatile three-way tool

In the LST, a level, a square at the lower right corner, and a 10-ft replaceable tape are combined into a triply-useful

tool. Accurate inside and outside measurements are said to be assured by the tape's sliding end-hook. The case is chrome plated. The LST sells for around $2.00. Keuffel & Esser Co.

17—SOLVENT DETERGENT with safety features

Composition 117 is a clear solvent designed to remove grease, oil and smut from machinery where water cannot be used. It is claimed equally effective in cleaning electrical equipment. The new material has a flash point of 185 F, Cleveland open cup, manufacturer states, and has an exposure tolerance

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They all work for you!

It takes the combined ability and experience of many people to engineer effective water conditioning.

Few plants, however, can afford to maintain or establish an internal staff capable of supplying the constant flow of engineering knowledge, the diversification of thinking, the thousands of creative and supervisory man-hours that are necessary to the engineering, planning, and control of an effective water conditioning program.

By assigning the responsibility for result-getting water conditioning in your plant to the Betz Organization, you gain immediately the services of field, staff, and consulting engineers, researchers, chemists, and production personnel . . . *plus* the basic objectivity of an "outside" organization providing individual attention to your individual problems.

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CONSULTANTS ON INDUSTRIAL WATER PROBLEMS

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rating 2½ times greater than trichlorethylene and 20 times that of carbon tetrachloride. You use it full strength, apply it by brush or immersion, or with a non-atomizing spray. For certain applications it is declared possible to use the material diluted with up to equal parts of high flash petroleum distillate. Oakite Products, Inc.

18—COMBINATION DRIVE for continuous pumping operation

This right-angle combination drive has been developed for municipal water supply stations, sewage disposal plants, and other installations where continuous or stand-by pumping service is essential. Sizes range from 30 to 150 hp and come in a wide selection of gear ratios. In normal operation, an electric motor, mounted on the disengaged drive, powers the pump. In the event of a power failure or electric motor breakdown, the drive is then readily engaged to transmit power from a stand-by combustion engine with little lost time under emergency conditions.

Among features incorporated in the unit are a heavy-duty motor stand and aluminum cover to protect external rotating parts from moisture and corrosion. A lower bearing retainer, which locks the hollow shaft against vertical movement, is designed to let the drive be engaged and operated up to a week's time without transferring the thrust load from the electric motor to the drive. Details are in Bulletins 1775 and F-1912. U. S. Electrical Motors, Inc.

19—LEVEL CONTROL is displacement type unit

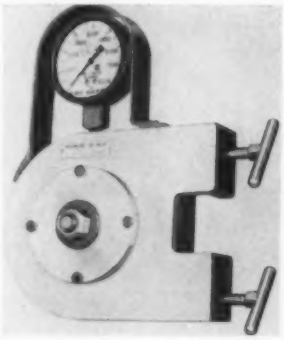
The Flexotrol Liquid Level Controller is announced as having eliminated both bearings and knife edges and as providing a trouble-free controller for all services. The new design introduces a torque table which replaces pivoting

members. The face of the torque table, engaging and driving the torque tube is free to twist under the action of the displacer. It is reported that performance of the controller is essentially constant and normal process residues do not hamper operation.

The units are available with internal displacer chambers or in models for direct displacer immersion in the process vessel. As an optional feature, direct mechanical liquid level indication can be provided as a final and complete check on the pneumatic system. Complete information on this unit is provided in Bulletin 456-1. Kieley & Mueller, Inc.

20—CALIBRATOR takes guesswork out of bolt tightening

Meeting bolting specifications is reported greatly simplified when impact wrenches are calibrated with this direct-reading bolt tension calibrator. With this portable unit, wrenches are adjusted and set right on the job site. The self-contained calibrator is clamped to a



convenient beam or column. Bolt, nut and washers of correct size are assembled into the calibrator and tightened with the impact wrench being adjusted. Bolt tension-in-pounds is then read on the calibrator gage. Regulation of air pressure and/or tightening time can be made until the specified number of pounds of tension are attained. The calibrator is usable with all ¾- ⅞- and 1-in. bolts that are at least 2½-in. long. It weighs 50 lb and comes in wooden case. Skidmore-Wilhelm Mfg. Co.

21—HYDRAULIC SWITCH is pneumatically actuated

The Type A-D Hydraulic Switch is introduced for the control of hydraulic cylinder operated valves. This switch is a pneumatically actuated dual diaphragm, four-way control valve which can be mounted close to the cylinders. Actuating three-way air valve or valves may be remotely placed. It may be used with a "controlled" valve position indicator on an operating panel or in a console. It can be used either for open-shut operation or for open-hold-shut operation. An advantage announced is that no water lines are required at the console or operating panel, resulting in less head loss due to friction and lower installation costs. Other features pointed out by manufacturer include sensitivity, low maintenance. Only moving part is the diaphragm. Bulletin 1215 gives details. Infilco, Inc.

22—PURIFIER designed to conserve water and steam

Instead of exhausting spent steam to atmosphere, the LS Hi-eF Purifier is installed in low pressure steam lines on exhaust side to remove oil, pipe scale and other impurities so that steam can be returned to boiler. This action not only reduces amount of raw feed water required, but actually cuts steam cost, it is said, since condensed water is less costly to generate into steam than raw water. Furthermore, condensate from purified steam also lessens danger of hot spots developing, it is pointed out, caused by impurities building up in boiler drums and tubes, thereby resisting proper dissipation of heat. It cleans steam without moving parts, filters or mesh screens but operates by means of a two-stage principle of separation that employs controlled centrifugal force to guide entrainment laden vapor through a series of vanes and baffles. In first stage of separation impingement against baffles removes larger droplets of entrainment, and in second stage, purifier removes fine mist entrainment with centrifugal force action through a separation element. The V. D. Anderson Co.

23—BURNER UNITS for new, conversion installations

Complete packaged combustion assemblies utilizing gas, oil or combination gas-oil firing are offered for modernizing or converting existing boiler or processing equipment or for new boiler or processing installations. These fuel burning systems include burner, automatic controls, forced-draft air supply, modulation firing control, ignition, piping and wiring and the refractory for the burner throat. Flexibility of the unit is designed to permit use on furnaces, ovens, vats, kilns, dryers, boilers and other types of industrial heat exchangers.

Five sizes are available for maximum firing rates from 3- to 25-million Btu per hour. The air atomizing oil conversion burner is designed to handle fuels from light distillate through heavy No. 6 residual oil. Pre-heaters are an integral part of the heavy-oil assemblies. Manufactured, mixed, natural, bottled, or special gas fuels can be burned in the partial pre-mixing design gas burner. The oil/gas burner is a combination of the two and is reported immediately interchangeable from one fuel to the other. Orr & Sembower, Inc.

Reader Service Cards on pages 113–114 make it easy to get further information on any of these products. Just circle the item numbers of the products you want to know more about.

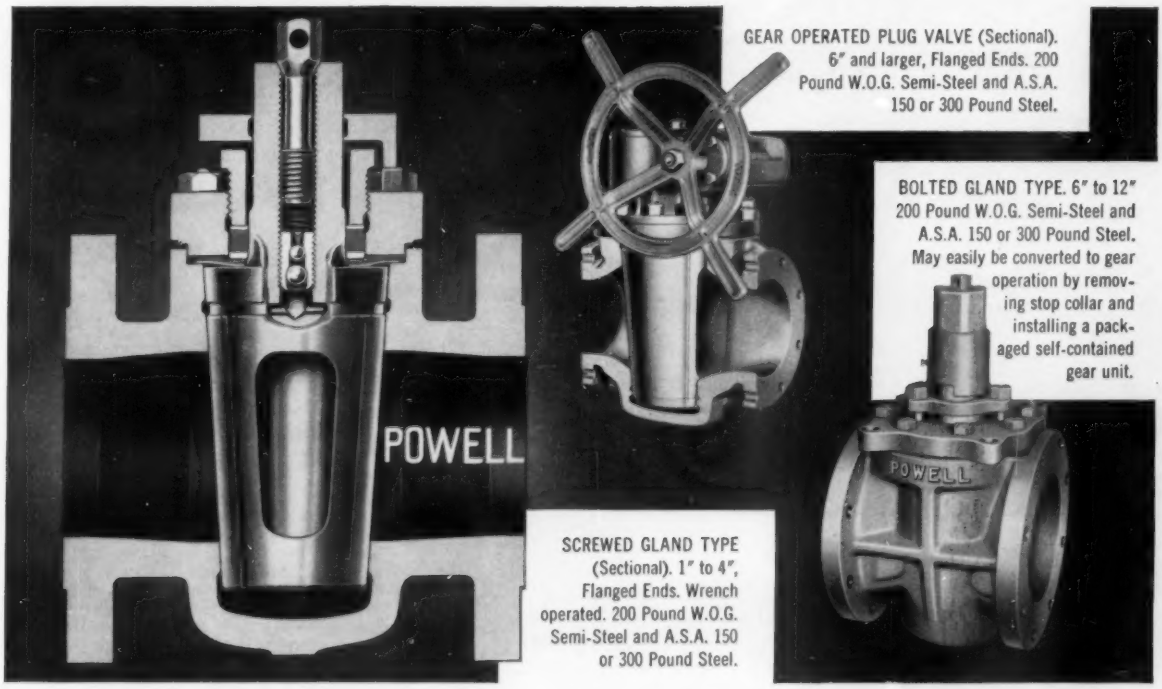
24—ALARM SYSTEM acts to indicate unsafe conditions

Larm-Tector Model 50 is a remote visual and audible alarm for use in connection with smoke controls, low water cutouts and flame failure systems, or wherever an alarm is required to indicate the presence of unsafe or other conditions. It is described as a convenient, completely assembled unit with a red alarm light, an audible buzzer of loud intensity, an adjustable time delay switch, with a pushbutton and silencing relay circuit. Complete unit is compact in size — only 4 in. long, 4 in. wide, 3⅝ in. deep. It is designed for operation on 110-v, 50 or 60 cycle; however a transformer for operation on other voltages is available. By automatically resetting itself after each operation, unit assures that alarm will resound on next indication of unsafe condition, company notes. When such a condition occurs, a red light comes on, then after a delay of 30 sec, buzzer sounds. Silencing pushbutton can be pressed any time after red light is energized to de-energize audible

POWELL

Lubricated Plug

VALVES



GEAR OPERATED PLUG VALVE (Sectional). 6" and larger, Flanged Ends. 200 Pound W.O.G. Semi-Steel and A.S.A. 150 or 300 Pound Steel.

BOLTED GLAND TYPE. 6" to 12" 200 Pound W.O.G. Semi-Steel and A.S.A. 150 or 300 Pound Steel. May easily be converted to gear operation by removing stop collar and installing a packaged self-contained gear unit.

SCREWED GLAND TYPE (Sectional). 1" to 4", Flanged Ends. Wrench operated. 200 Pound W.O.G. Semi-Steel and A.S.A. 150 or 300 Pound Steel.

Powell Lubricated Plug Valves maintain our 110-year tradition of quality and precision. Only the finest available materials are used. And painstaking quality control is rigidly enforced through each and every step of manufacture.

Features include quick and positive operation—just a quarter-turn to open or close. Lubricant grooves surrounding each port provide a positive seal when the valve is closed. In an open position, seating surfaces are not exposed.

Valve users who want one source of supply for lubricated plug as well as all types of bronze, iron, steel and corrosion-resistant valves will want full details on Powell Lubricated Plug Valves.

Available in Steel and Semi-Steel through distributors in principal cities. If none is located near you—or if you need help on valve problems—write direct to

PERFORMANCE
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BRONZE, IRON, STEEL AND CORROSION-RESISTANT VALVES

The Wm. Powell Company, Cincinnati 22, Ohio . . . 110th YEAR

The source of supply for all valve needs!

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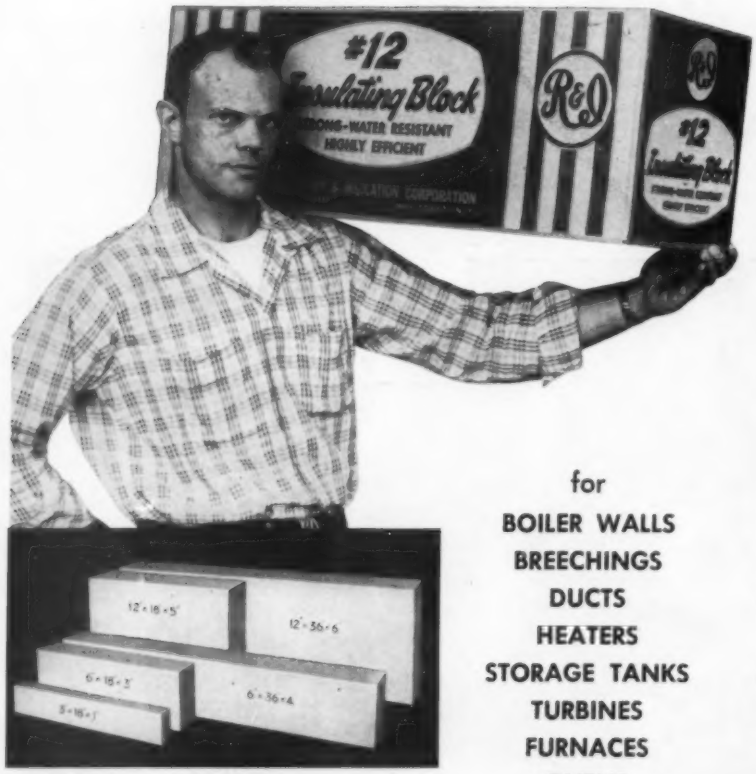
It's Stronger



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- *Unaffected by steam or water*
- *High insulating efficiency*

R & I #12 Block applied to refractory tile of boiler wall.

Available in thickness from ½" to 12" and sizes from 3" x 18" to 12" x 36". Prompt delivery.

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REFRACTORY BONDING AND CASTABLE CEMENTS
INSULATING BLOCK, BLANKETS AND CEMENTS

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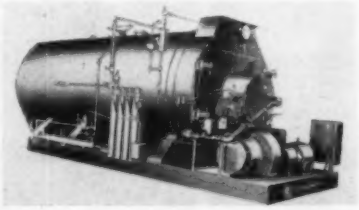
alarm only. Time delay switch is adjustable anywhere from a no delay to a maximum of 2 min. An added safety feature cited is that alarm cannot be permanently disconnected from the circuit by operator. Way-Wolff Associates.

25—STEAM GENERATOR with unusually high capacity

The C-26,000 is a 750 hp package steam generator, announced as the highest capacity fire-tube boiler, and designed to deliver 26,000 lb of steam per hour at over 80 per cent efficiency. Because of



the cyclonic principle incorporated in the design, unit is no larger than most 500 hp package generators, company states — overall dimensions are 28 ft by 9 ft 6 in. by 10 ft 8 in. Designed for heavy oil or gas, boiler can be adapted to burn either LP-gas or light oil. According to company, this generator combines advantages of package generators (high efficiency, simplified automatic operation, compact size, inexpensive installation) with steaming capacities associated with boilers assembled at plant site. Cyclotherm Div., National-U. S. Radiator Corp.

26—SOLUTION for waterproofing of electrical equipment

Electro-Seal 55-A is a water repellent solution developed for waterproofing electrical equipment of all types. Described as a non-toxic, transparent solution which can be brushed on or used as a bath into which the units are dipped, it forms a thin, tough protection after drying which becomes a part of each unit. It is reported that on-the-job treated equipment can be placed back in operation within a day. From a waterproofing standpoint, company notes, this film could withstand immediate use without adverse results for an indefinite period if production called for immediate return to action. In addition to protection against water, alcohol, alkalis, and acids, it affords effective resistance to rust, tarnish, and corrosion, and has a high dielectric characteristic plus low vapor transmission. Also, electric hand tools can be used wet without harm resulting from shock, according to manufacturer. Electro-Seal is available 1-, 5- and 55-gal containers. Electro-Seal Co., Div. of Arcan's Inc.

27—SEALED SWITCH is high capacity unit

This sealed, roller plunger switch, the No. BAFI-2RQN8, is designed to handle inrush currents up to 75 amp. Manufacturer explains that the switch is made oil-tight by integral O-rings around the bushing and plunger and a ring-type seal between the cover and the housing. Other features announced include an actuator that is field adjustable through 360 deg to allow operation from any

Another Feature of the FW Series "SC" Standard Boiler

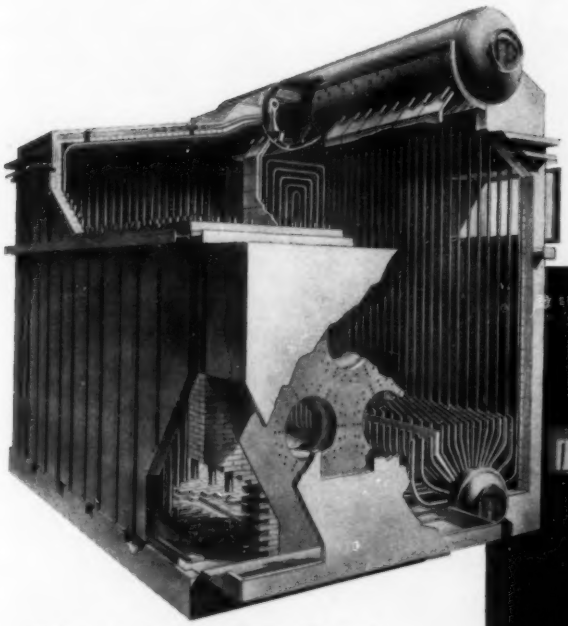
PRESSURE-TIGHT CASING

permits

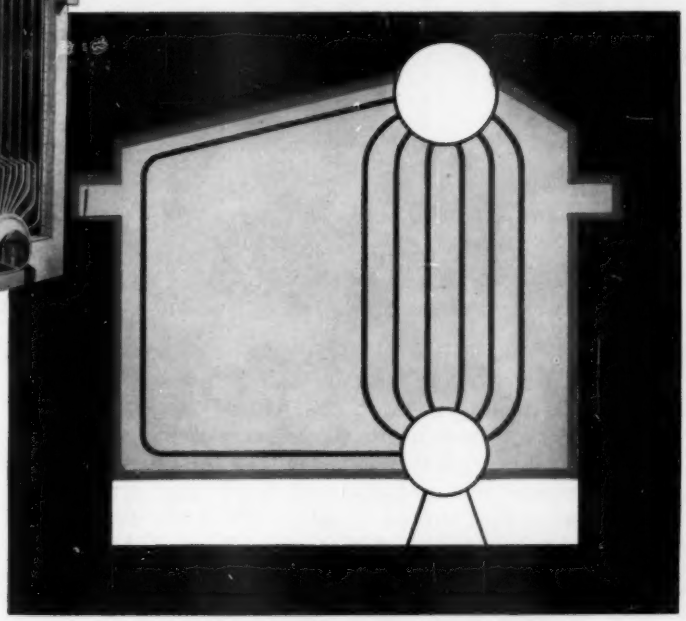
LOWER OPERATING COST

through

MORE EFFICIENT COMBUSTION



Cut-away view of Foster Wheeler "SC" Series Standard Steam Generator



OTHER FEATURES AT A GLANCE

- Completely water-cooled walls
- Over 19-foot firing depth
- Unrestricted circulation
- Fully drainable superheater
- Efficient convection surface
- Bottom supported unit
- Steam purifying system
- Full insulation

THE ALL-WELDED steel casing of the Foster Wheeler Series "SC" Steam Generator forms a rigid, pressure-tight unit which can be arranged for either pressurized or balanced-draft operation.

By eliminating all possible sources of air or gas leakage, this pressure-tight design increases combustion efficiency and contributes to higher fuel economy per pound of steam per hour. No sliding seals are necessary as the stationary casing is welded to the drums and the differential in expansion provided for by an integral horizontal expansion joint which encircles the entire unit. Pressure-tight ports are provided for observation of burners and flame.

These cost-saving FW Series "SC" Steam Generators are available in capacities from 50,000 to 150,000 lb/hr, for pressures to 1500 psi and superheated steam temperatures to 950F. For further information, write for Bulletin B-55-4. *Foster Wheeler Corporation, 165 Broadway, New York 6, N. Y.*

FOSTER WHEELER

NEW YORK • LONDON • PARIS • ST. CATHARINES, ONT.

For more data circle 534 on Post Card

. . . and the P-D Tubular is even more radical. Unique internal ducting, called *PLENAFLO, actually provides a plenum *within* the collector casing which permits direct gas flow to the inlet of the tubes *unhampered by a maze of outlet tubes.* It also permits the use of tube bundles so designed that the gas *never has to pass more than two tubes* to reach the most isolated central tube. This patented feature reduces resistance and eliminates gas recirculation that can occur with outlet tubes of varying length.

Further improvement of gas flow was accomplished by designing the tube inlet slots to permit the gas to enter the tube at a natural angle and around the complete periphery of the tube. This reduces sudden changes in direction of gas flow and attendant wear.

Ask our project engineers for information on this unique PLENAFLO collector. Its efficiency and limited space requirements will be of particular interest. Available in either vertical or horizontal tube design sheets, it assures installation flexibility.

Write today for Bulletin on this radical design.

*Trademark

Project Engineers
THE THERMIX CORPORATION
GREENWICH, CONN.
(Offices in 38 Principal Cities)
Canadian Affiliates: T. C. CHOWN, LTD., Montreal 25, Que.

pd

Designers and Manufacturers
PRAT-DANIEL CORPORATION
SOUTH NORWALK, CONN.

POWER DIVISION: Tubular Dust Collectors, Forced Draft Fans, Air Preheaters, Induced Draft Fans, Fan Stacks

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direction; a rugged, corrosion-resistant steel roller, and a heavy plunger bushing. Although enclosure is compact, ample wiring space and side facing screw terminals allow easy installation. The aluminum enclosure protects switching unit from physical damage and also provides a means for mounting and for conduit connection. The switch is available with actuator positioned either to right or left. Contact arrangement is single-pole, double throw. The switch is UL listed at 20 amp 125, 250 or 460 v a-c; ½ amp 125 v d-c 2 hp 230 v a-c; 10 amp 125 v when controlling tungsten filament lamp loads on a-c circuits. Micro Switch, Div., Minneapolis-Honeywell Regulator Co.

28—VIBRATION MOUNT need not be fastened to machine

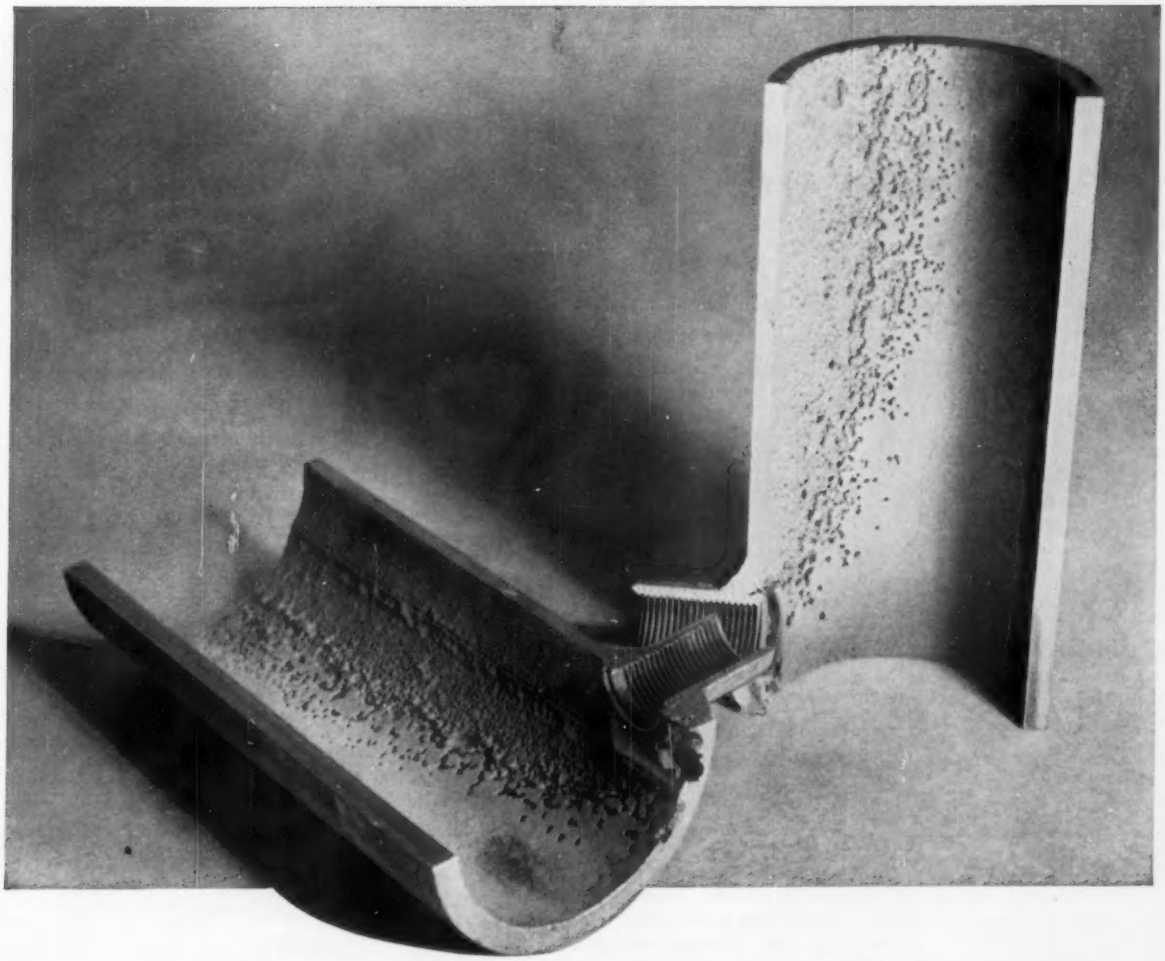
The Universal Lev-Elasto Damper is announced as a low cost machinery mount that speeds installation and relocation of all types of equipment, stops vibration transmission, lowers noise levels, and will accommodate all job conditions without job-site alterations.

Features include internal leveling adjustment permitting installation anywhere under machine, regardless of position or availability of bolt holes in base, or of base thickness; no adjusting bolts protruding from top of mounting; no bolting of machine to mounting because of non-skid felt pad on top plate. However, mounting can be cemented, or bolted through tapped hole provided, and damper can be cemented to floor if desired. Other advantages cited include: no lagging to floor, yet machines won't creep because of non-skid tread design; no shimming because twin adjusting bolts simplify leveling; single piece assembly, permitting mounting and machine to be moved and relocated as a unit. It is available in 9 sizes for loads ranging from 65 to 12,000 lb per damper, and priced from around $6 to $35. The Korfund Co., Inc.

29—GAS VALVES feature fast closing, slow opening

For use with company's flame safeguard systems, the Fireye Series 81L Valves are motor operated gas valves, having a compression-type spring designed to automatically shut off fuel in 0.8 sec. A heavy-duty electric drive unit controls the opening rate to reach 75 per cent of maximum fuel flow in 6 sec. Another feature is availability of a position indicating switch, which performs as a safety interlock. If, prior to light-off of a burner, the valve is open as little as a fraction of an inch, the switch will not allow the light-off to take place, manufacturer explains. Instead, the electric circuit to the burner control remains off until the valve is completely closed.

In case of flame failure or loss of electric power, or on operation of limit switches or other interlocks in the burner control circuit, closing of the valves is



PIT-POCKED PICKPOCKET

In power-demanding industries, pitted pipe means out-of-pocket expense. The annual losses in labor and materials to replace equipment damaged by cavitation and corrosion reach staggering proportions.

The corrosive attack against this pipe was accelerated by mechanical action. Cold water injected into a high-pressure condensate return line caused steam collapse, resulting in violent hammering and cavitation-erosion damage. Because shock forces disrupted protective films on the interior surface of the pipe, failure occurred rapidly in this short section.

Dearborn Engineers spotted the cavitation problem, and recommended design changes which eliminated the trouble. Thereafter the entire return line system was fully protected by Filmeen.*

Dearborn Filmeen, a concentrated amine treatment, forms a continuous corrosion-inhibiting barrier between condensate and metal. This non-wettable film protects against both carbonic acid and oxygen corrosion. Filmeen readily disperses in hot condensate, permitting continuous feed direct to boiler or steam system.

Take advantage of Dearborn's Water Treatment and Engineering "know-how." Your Dearborn Representative will demonstrate Filmeen's efficiency in combatting destructive corrosion. He will survey your system and recommend control measures and feeding arrangements best suited to your plant requirements. The coupon will bring full details.

**FILMEEN—U.S. Pat. No. RE-23614 reserves to Dearborn Chemical Company and its licensees exclusive right to the use of octadecylamine for water treatment.*

Dearborn®

combatting corrosion wherever it occurs

Dearborn Chemical Company
Merchandise Mart Plaza, Dept. PG
Chicago 54, Ill.

☐ Have a representative call.

☐ Send me more information on Dearborn Filmeen Water Treatment Service.

Name.....*Title*.....

Company.....

Address.....

City.....*Zone*.....*State*.....

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BELMONT BEL-VEE

The "Pressure-Sealing" V-Ring Packing

SEATS AUTOMATICALLY

•

KEEPS EQUIPMENT RUNNING SMOOTHLY. CUTS MAINTENANCE

•

BASIC MATERIAL COMBINATIONS FOR VARIOUS SERVICES

•

A SIZE FOR EVERY ROD & STUFFING BOX

Scientifically designed to make the pressure seal itself, BEL-VEE Rings expand toward the rod and stuffing box wall, on the power stroke or with increased pressure, to automatically form the pressure seal.

On the return stroke, or with pressure relaxed, BEL-VEE Rings contract from the rod for free movement with minimum friction.

BEL-VEE Rings are individually molded in a number of basic material combinations. Offered in sets for pressures to 6000 psi. for sealing reciprocating rods of pumps, engines, compressors, hydraulic equipment and valve stems—handling water, oil, solvents, steam, air and gas.

BEL-VEE Rings are made in practically every rod and stuffing box size. Ask the U.S.G.-Belmont Distributor nearest you or write for Belmont Bulletin No. 4R10.

THE BELMONT PACKING & RUBBER COMPANY
Butler & Sepviva Streets
Philadelphia 37, Pennsylvania

U.S. GASKET • BELMONT PACKING

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said to be assured by two principles of construction: a "double safeguard" release, wherein either of two independent releases will trip the valve; and a shearing action by the valve disc, which literally cuts through dirt or scale on the valve seat. Announced as approved by Underwriters' Laboratories and Factory Mutual, these valves come in sizes from 1 to 6 in. Higher capacities and lower pressure drops are achieved in each by full area port and straight-through body design. Bulletin CV-32 describes these valves. Combustion Control Div., Electronics Corp. of America.

30—SOLENOID VALVE for safety shut-off applications

Available in sizes from ¾ to 6 in. IPS and pressures from 25 to 100 psi, the ASCO Safety Shut-Off Valves, Bulletin 8022, are used in gas supply lines leading to boilers, furnaces, ovens and other heating equipment to shut-off fuel automatically and instantly upon failure of power. The 1¼ to 3 in. sizes are reported to meet requirements for safety shut-off valves (on gas service) in safety codes.

Designed to control flow of manufactured, natural and L-P gases in a maximum ambient of 104 F, valves handle various grades of fuel oil and noncorrosive liquids and gases.

"Y" type body and oversize ports provide flow that is almost equal to that of a straight-through gate type valve, says company; integral crown type seat and soft composition disc provide tight shut-off, and double Buna N rubber sliding seal on valve stem eliminates leakage. The valve may be mounted in any position. Normally closed valves can be opened manually by depressing a lever button and rotating operating lever to the close position. If current is on, valve will latch allowing operating lever to be rotated to open position. Valves are held open by a mechanical latch only while holding solenoid is energized. They close independent of operating lever when holding solenoid is de-energized, can be closed manually. Automatic Switch Co.

Described on these pages are new and improved products. Use Reader Service Cards on pages 113–114 to ask for more information. You may also use the postcards to request information on the advertised products.

How Steam Trap Standardization *reduces* *Installation and Maintenance Work and Cost*

No Bypasses Needed. Traps can be replaced in a couple of minutes by uncoupling the unions and installing a "spare" trap complete with proper length pipe connections and half unions.

ORIFICE SIZES	
PRESSURE	SIZE
0-40	5/32
40-60	9/64
60-150	7/64

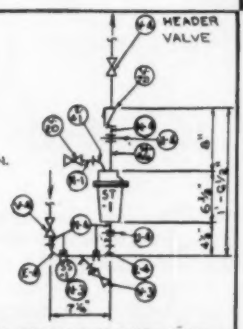
CAPACITY • 0-300 #/HR

NOTES:

DIMENSIONS SHOWN ARE FOR MINIMUM SPACE INSTALLATION.

IN LONG RUNS - PIPE TO BE PITCHED TOWARD TRAP.

TRAP TO BE INSTALLED BELOW DRAIN POINT IF POSSIBLE. IF NOT POSSIBLE, A CHECK VALVE MUST BE INSTALLED ON INLET SIDE OF TRAP.



BILL OF MATERIAL FOR TYPICAL STEAM TRAP HOOK-UP

MARK	PCS.	MAT'L	DESCRIPTION
ST-1	1	ELEC. ST.	½" STEAM TRAP - ARMSTRONG #211
SS-1	1	CAST IRON	½" STRAINER - 250# W.S.P. - [redacted]
V-4	2	BRZ	½" GATE VALVE - SCRD - 200# W.S.P. [redacted]
V-20	1	BRZ	½" GLOBE VALVE - SCRD - 200# W.S.P. [redacted]
V-3	1	BRZ	½" GATE VALVE - SCRD - 200# W.S.P. - [redacted]
V-70	1	BRZ	½" CHECK VALVE - SCRD - 200# W.S.P. - [redacted]
E-4	2	MALL. FTG.	½" - 90° SCRD ELL - 2000#
L-41	1	MALL. FTG.	½" - 90° STREET ELL - 3000# - [redacted]
U-4	2	MALL. FTG.	½" UNION - 2000# [redacted]
N-1	1	ST'L	½" SHORT NIPPLE - SCH. 80 - SEAMLESS ASTM A-53
N-3	1	ST'L	¾" SHORT NIPPLE - SCH. 80 - SEAMLESS ASTM A-53
N-4	6	ST'L	¾" SHORT NIPPLE - SCH. 80 - SEAMLESS ASTM A-53
N-4/4	1	ST'L	½" - 4" LG. NIPPLE - SCH. 80 - SEAMLESS ASTM A-53

Standardized hookup includes test valve for trap testing, strainer, blowdown valve for cleaning trap, shut-off valves and unions for quick replacement.

Trap Maintenance Costs Reduced $25,000 per Year with Armstrongs

Major reductions in steam trap installation and maintenance work and cost can be achieved by standardization on one make of trap which, in turn, permits standardized hookups. A major chemical company reports an annual maintenance saving of $25,000 since installing 4000 Armstrong traps according to the drawing and photograph shown here. Additionally, trap parts inventory is reduced and purchasing is simplified.

Traps of a Size Interchangeable. Note that exact dimensions are given for the pipe fittings, including nipples connected to each size of trap. When a trap needs repair, the unions can be uncoupled, the trap lifted from the line, and a "spare" carrying identical pipe connections slipped in place. In as little as one or two minutes, a faulty trap is replaced. It is then repaired and takes its place as a "spare".

$25,000 Trap Maintenance Saving. Records on the Armstrong trap installation described here show that the cost of repair parts was approximately $10,000 less annually than with the traps previously used. Reduction in maintenance labor brings the total saving to $25,000, per year. *And, fuel savings attributable to the traps are at least equal to the maintenance saving.*

FOR COMPLETE INFORMATION on the traps that slash maintenance costs ask for the Armstrong Steam Trap Book containing complete data plus selection, installation and maintenance recommendations. Call your local Armstrong Representative or write.

ARMSTRONG MACHINE WORKS, 810 Maple Street • Three Rivers, Michigan

ARMSTRONG STEAM TRAPS

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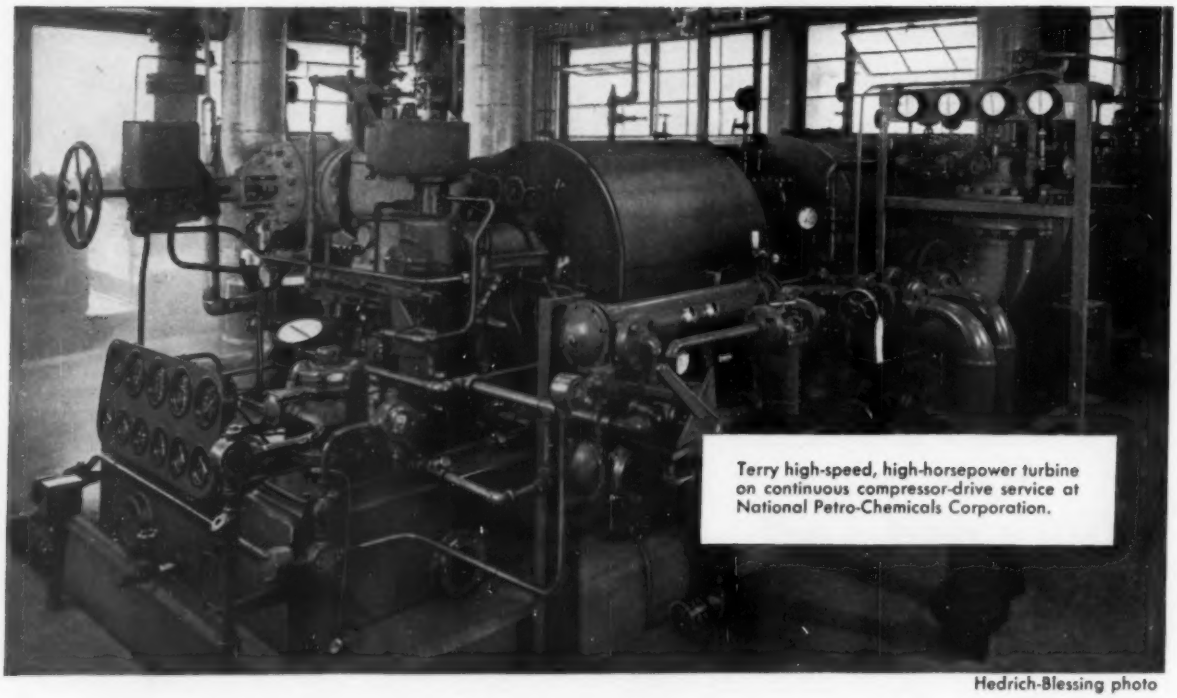
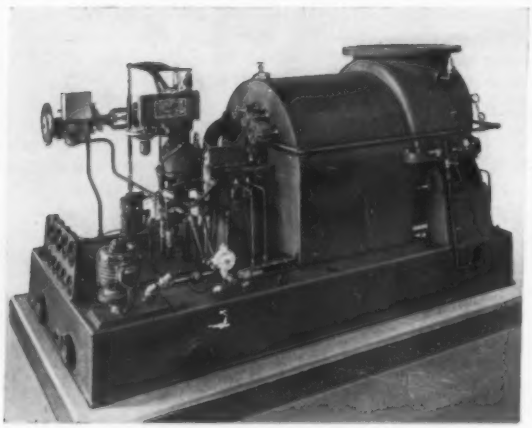


Terry high-speed, high-horsepower turbine on continuous compressor-drive service at National Petro-Chemicals Corporation.

Hedrich-Blessing photo

At National Petro-Chemicals Corporation . . .

Terry high-speed compressor-drive turbines provide continuous 'round-the-clock service



One of the two 5400 hp., 7486 rpm turbines built for the Tuscola plant of National Petro-Chemicals Corporation.

In the fall of 1953, five Terry multistage turbines were placed on day-and-night duty at the Tuscola, Illinois, Plant of National Petro-Chemicals Corporation. They drive high-speed compressors used to compress hydrocarbon gases in the production of ethylene.

The *excellent performance of these initial units later resulted in the installation of two more Terry machines.* These were placed in service some two years later.

In all, the seven turbines total more than 30,000 hp. They range in capacity from 3300 to 5400 hp., and in speed from 7500 to 9700 rpm.

The National Petro-Chemicals installation, and the thousands of other units serving in refineries and chemical plants throughout the world, are testimony to the low maintenance and consistent reliability of Terry turbines. Put Terry to work for you. Write for further information.

THE TERRY STEAM TURBINE CO.

TERRY SQUARE, HARTFORD 1, CONN.

TERRY

TT-1207

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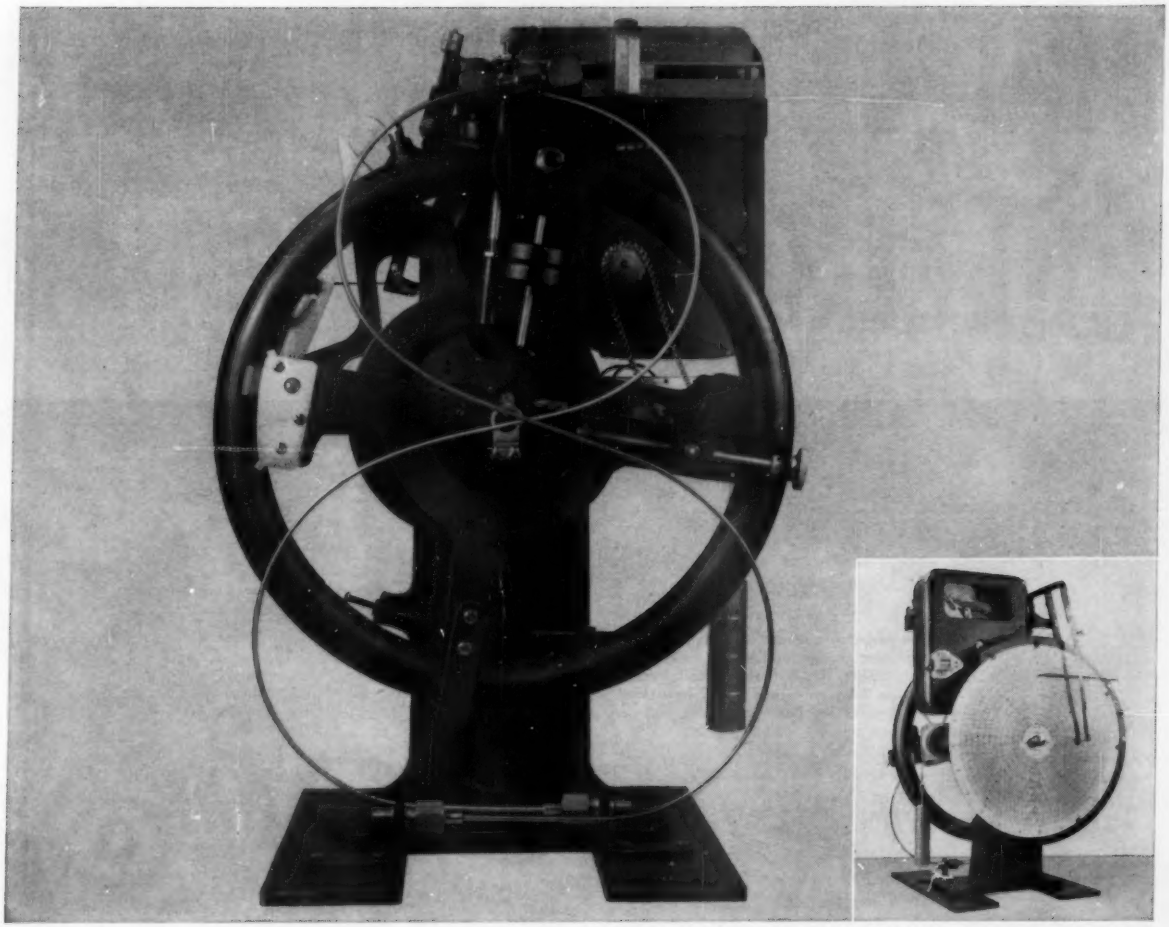

Recording and integrating Model 2656
(case removed)

Simple, direct action makes

HAGAN RING BALANCE METERS

tops in Accuracy and Dependability

Simple, direct action and sturdy construction assure dependable, trouble-free service in Hagan Ring Balance Meters. The famous Ring Balance principle produces high accuracy, even at low differentials and at low rates of flow.

Hagan Ring Balance Meters are available for any gas or liquid flow measurement. Check these many outstanding features and see how they can help you get accurate and dependable metering with really low maintenance.

- **Calibration of meter may be checked with dead weights in a few minutes, without disconnecting the meter from the line.**
- **No stuffing boxes are used in Ring Balance Meters.**
- **No mechanism in contact with fluid being measured.**
- **The differential measuring range of any ring is readily adjustable over a 7 to 1 ratio.**
- **Calibration is independent of the amount of sealing liquid.**
- **A complete series of interchangeable sensing elements is available for measuring full scale differentials from 1" to 420" WC, at static pressures up to 3000 psig.**

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HAGAN BUILDING, PITTSBURGH 30, PA.

HAGAN

Systems and Components for: Boiler Combustion Control, Metallurgical Furnace Control, Process Control, Aeronautical Testing Facilities • Industrial Water Treatment • Chemicals for Water Conditioning

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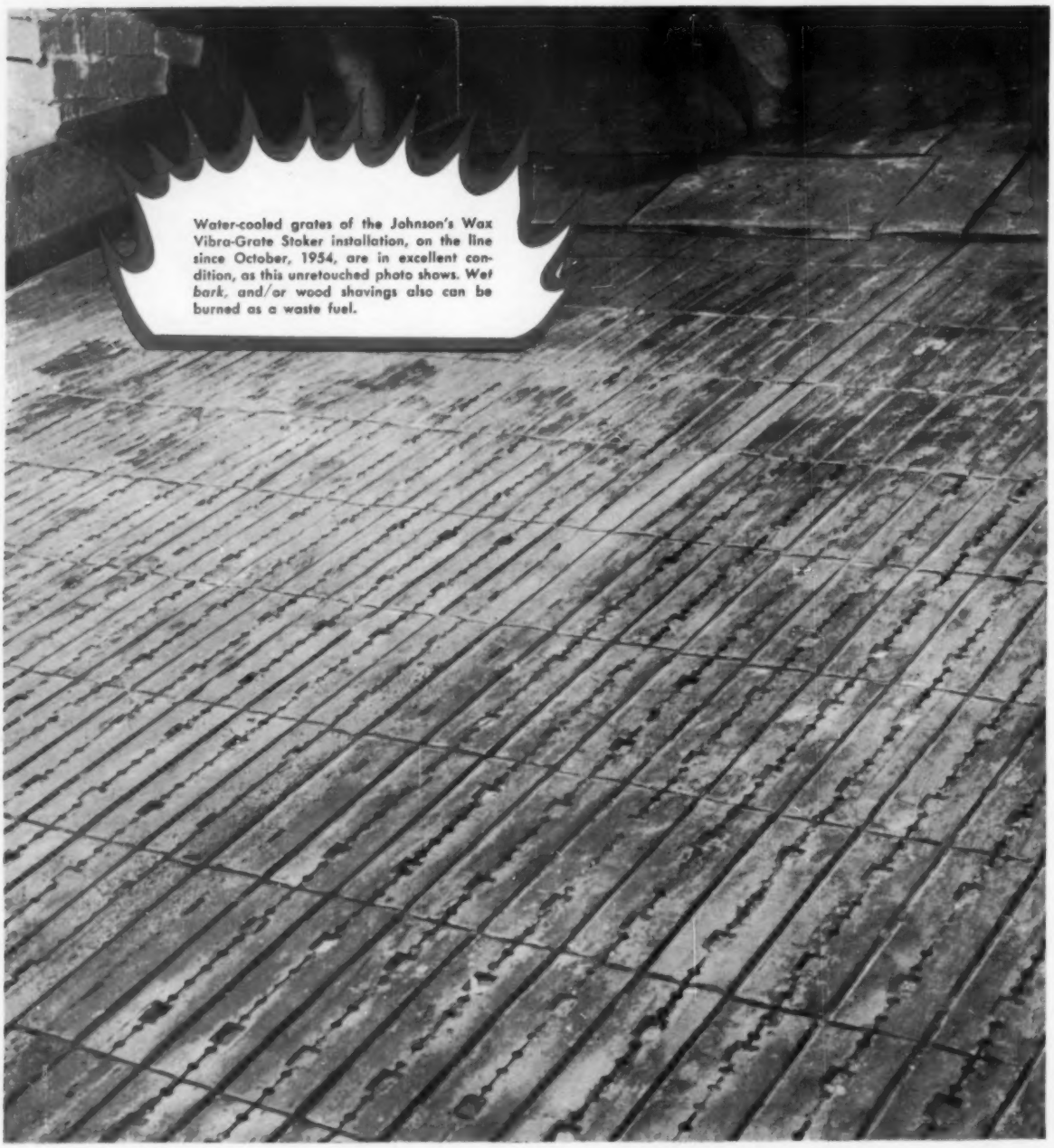
PROVED PERFORMANCE SELLS EIGHT NEW AE



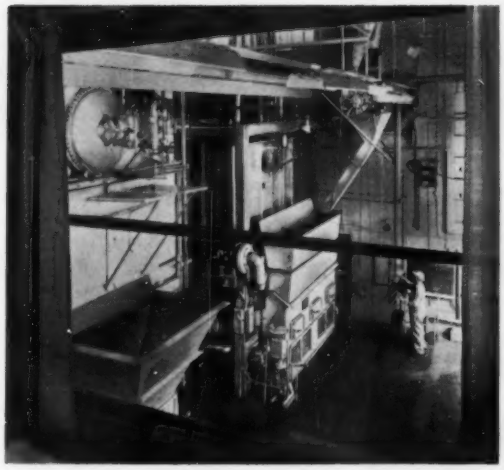
Water-cooled grates of the Johnson's Wax Vibra-Grate Stoker installation, on the line since October, 1954, are in excellent condition, as this unretouched photo shows. Wet bark, and/or wood shavings also can be burned as a waste fuel.

OVER 24 MONTHS VIBRA-GRATE STOKERS

Two full years of outstanding service from the Vibra-Grate stoker in the Racine, Wisconsin plant of S. C. Johnson & Son, Inc., manufacturers of Johnson's Wax, have resulted in eight new orders for Vibra-Grates from both public and private users.

A personal examination of the Johnson's Wax installation by technical experts of customer companies convinced them that all claims made for this outstanding stoker were modest compared with its performance records. Grates were in almost new condition, as the unretouched photograph shows – proof that Vibra-Grates can both deliver heat – and take it!

So, if you're thinking of adding a new power plant – or modernizing your present one, write for full details on the Vibra-Grate today.



First commercial installation of its kind in the U. S., the Vibra-Grate Stoker at Johnson's Wax burns low grade coal without smoke, needs no dust-collector, and is water-cooled for long life. Maintenance to date has been zero.

EIGHT AE ADVANTAGES MEAN MAXIMUM OPERATING EFFICIENCY FOR EIGHT NEW INSTALLATIONS

Manufactured by American Engineering Company, makers of the world-famous Taylor Stoker, modern Vibra-Grates provide cost-conscious power plant operators with eight special advantages:

- Unusually effective air seals to insure high CO_2, even at very low ratings
- Freedom from smoke at both high and low steaming rates
- No need for costly dust collectors
- Satisfactory burning of both high and low volatile coals, as well as lignite
- Really effective air zoning from this stoker's modern type of grate; air divisions cannot become leaky and useless
- Minimum maintenance, because of the stoker's water-cooled grate
- High efficiency at all ratings
- Water-cooling protection when burning liquid or gaseous fuels

AMERICAN ENGINEERING COMPANY

DEPT. S-101, WHEATSHEAF LANE & SEPVIVA STREET, PHILADELPHIA 37, PA.

Canadian Subsidiaries: Affiliated Engineering Corporations, Ltd., Montreal, P.Q. . . . Bawden Industries Ltd., Toronto, Ont.

AF products are: Taylor, Perfect Spread and Vibra-Grate Stokers, Hele-Shaw and Hydramite Fluid Power, Lo-Hed Hoists, Lo-Hed Car Pullers, Marine Deck Auxiliaries.

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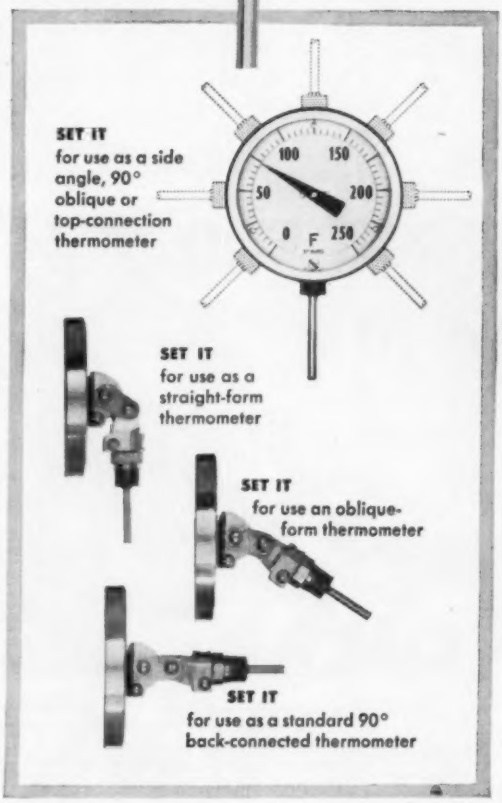
"Every Angle" Design Maxivision® Accuracy Bi-Metal Actuation

Now... all 3 in one 'American' Thermometer

Only this new American Thermometer* gives you the three features most demanded in a dial thermometer. The "Every Angle" design allows you to install this thermometer *anywhere* . . . then angle it in the direction that provides easiest reading. The anti-parallax Maxivision dial guarantees the surest, sharpest, easiest reading. Graduations are carried on a raised ring, set close to the cover glass, with an index-type, functional pointer set at the same level. The result – no perspective effect – parallax error practically eliminated. Finally, bi-metal actuation insures high sensitivity, economy, and surety of operation.

Install the new American "Every Angle" Bi-Metal Dial Thermometer anywhere – inside or out. Its climate-proof case defies any weather condition. The full use of these thermometers in any process plant makes possible temperature readings with the same ease and facility of those of a pressure gauge. Write today for complete information. Ask for Bulletin 148.

*Pat. App. For



SPECIFICATIONS

5-Inch Type 5-6060 American "Every Angle" Bi-Metal Dial Thermometer

Temperature Ranges: From minus 80° to plus 1000° F. Accuracy within 1% of range. *Dial Size:* 5". Scale approximately 10½" long. *Bi-Metal Coil:* Low mass, with single helix close to inside wall of stem assures high sensitivity. Silicone fluid dampens vibration, accelerates transfer, speeds response. *Case:* Stainless steel. *Bezel:* Threaded to case. *Front:* Clear, extra-heavy glass set in channeled gasket to seal case. *Pointer:* Functional type, adjustable from front. *Stem:* Lengths – 4" to 24", 18-8 stainless steel. All joints welded. *Connection:* Fixed, ½" NPT. *Separable Sockets:* Available in all materials and sizes normally required.

PHONE your Industrial Supply Distributor for experienced attention to your needs. He is always ready to help you ward off costly shut-downs through fast delivery from local stocks.

AMERICAN INDUSTRIAL INSTRUMENTS

A product of **MANNING, MAXWELL & MOORE, INC.** STRATFORD, CONNECTICUT

MAKERS OF 'AMERICAN' INDUSTRIAL INSTRUMENTS, 'CONSOLIDATED' SAFETY AND RELIEF VALVES, 'AMERICAN-MICROSEN' INDUSTRIAL ELECTRONIC INSTRUMENTS, *Stratford, Conn.* 'HANCOCK' VALVES, *Watertown, Mass.* 'CONSOLIDATED' SAFETY RELIEF VALVES, *Tulsa, Oklahoma.* AIRCRAFT CONTROL PRODUCTS, *Danbury & Stratford, Conn. and Inglewood, Calif.* "SHAW-BOX" AND 'LOAD LIFTER' CRANES, 'BUDGIT' AND 'LOAD LIFTER' HOISTS AND OTHER LIFTING SPECIALTIES, *Muskegon, Mich.*

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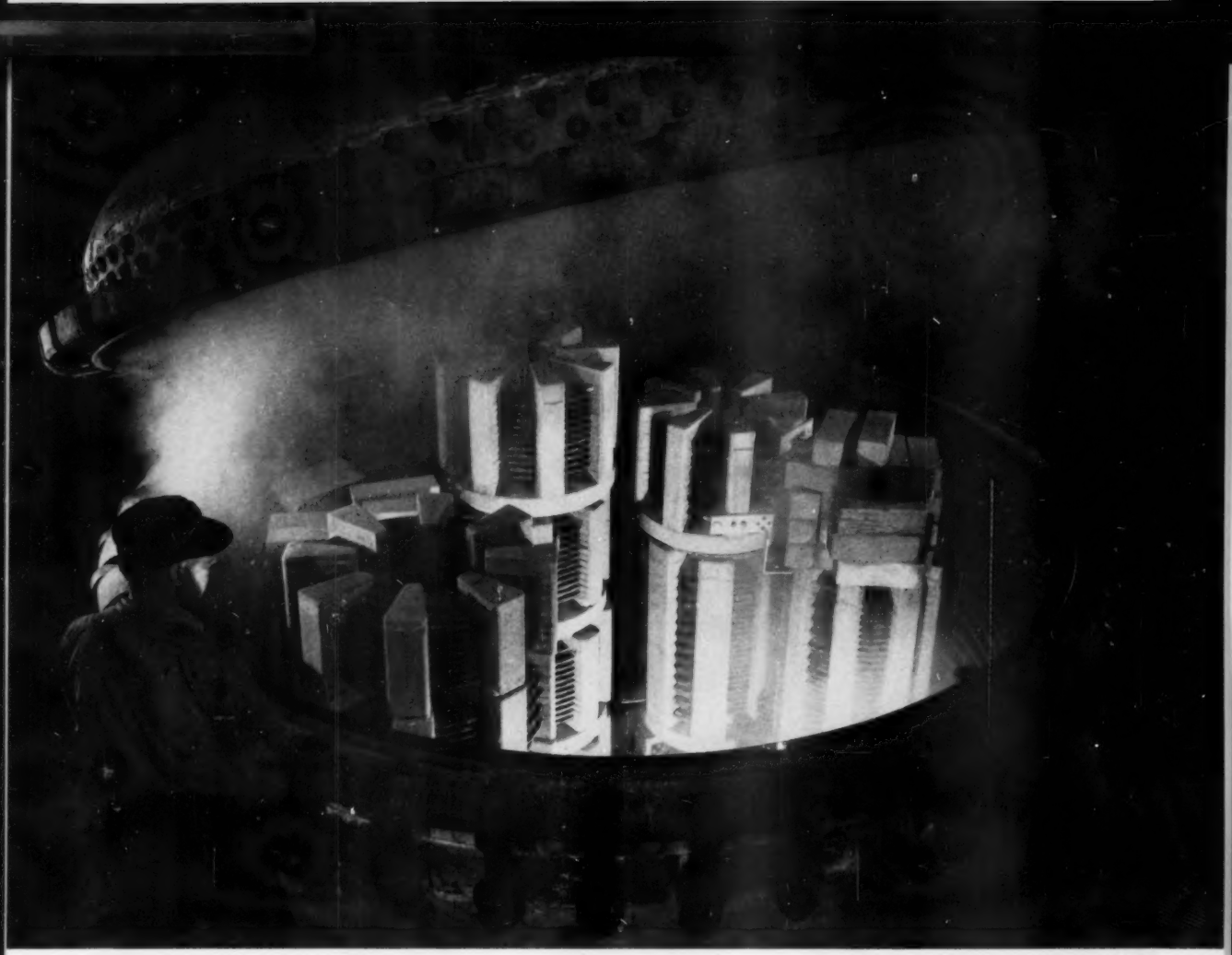

PROVEN WET-STEAM CURING PROCESS MAKES

General Electric cast-in-concrete reactors stronger, more reliable

37 YEARS OF SERVICE have been achieved by these G-E cast-in-concrete reactors at Fall River Electric Light Co., Fall River, Mass. Twelve reactors, installed in 1919, are as strong as ever and have required practically no maintenance.

RELIABILITY that begins at the moment of installation and lasts through a longer life is assured to you by General Electric's time-proven methods of manufacturing cast-in-concrete reactors. Using its exclusive wet-steam curing process, G.E. achieves in two days a degree of concrete curing which would be obtained only after several weeks of normal, in-service curing. This unique 180° C steam bath gives you stronger, more reliable reactors than any other curing method in use today.

PROOF OF THE STRENGTH of properly cured concrete reactors is demonstrated daily by thousands of G-E reactors in service across the country (see photo left). For other benefits of G-E reactors, contact your local G-E Apparatus Sales Office or write General Electric Company, Schenectady 5, New York. 422-32

Progress Is Our Most Important Product

GENERAL ELECTRIC

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THE BEST DEFENSE AGAINST **IMPINGEMENT ATTACK...** IS MODERN CONDENSER TUBES

Impingement corrosion, sometimes called corrosion erosion or inlet-end corrosion, need not be a costly problem — even in the face of today's accelerated operation of condenser equipment. A modern tube alloy — one developed to resist the abrasive effect of rapidly moving water — assures longer tube life, substantially reduces down-time costs.

FOR EXAMPLE: *In tests and in operation, Bridgeport Arsenical Aluminum-Brass, Alloy #53, stands up well where high water velocities and impingement corrosion are encountered. In addition, this alloy performs well in polluted waters and resists dezincification.*

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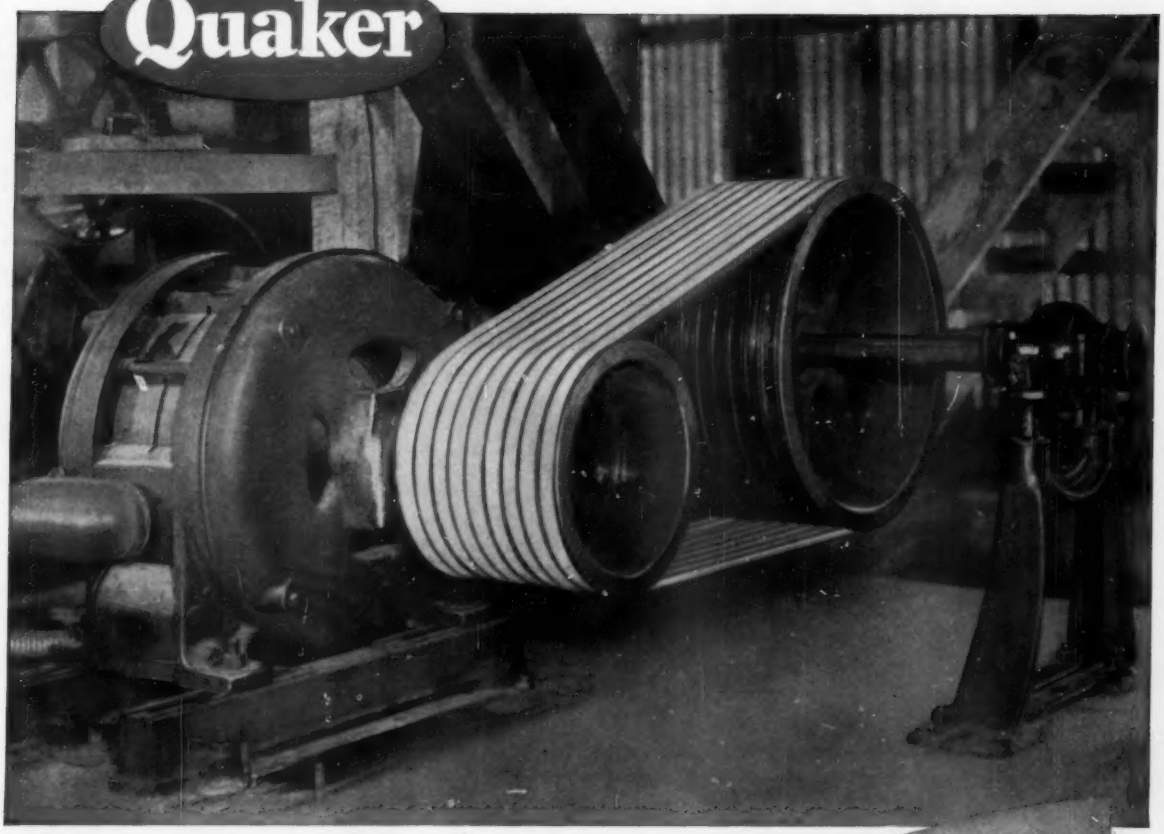

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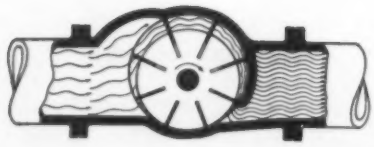

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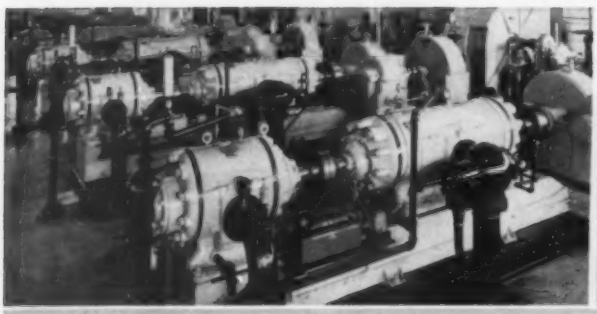

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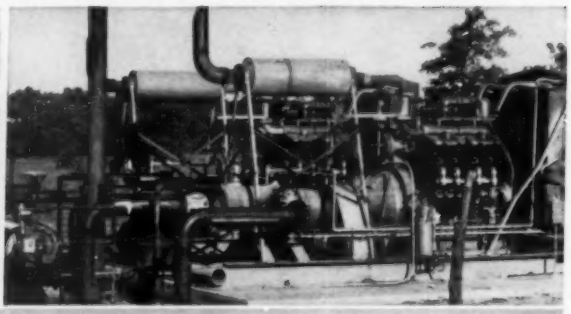

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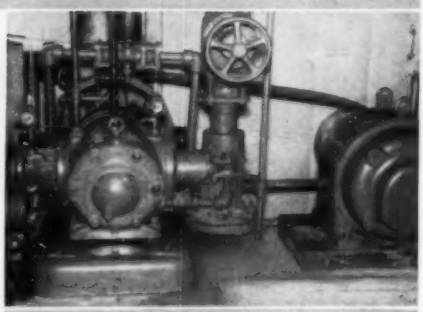

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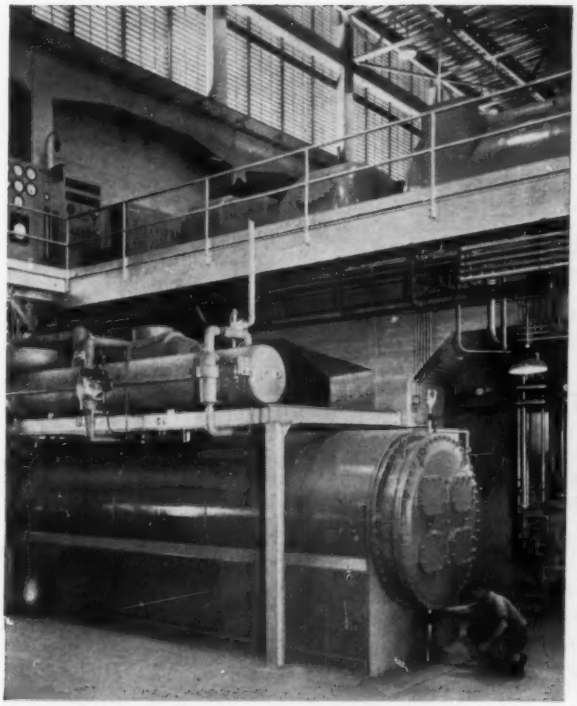
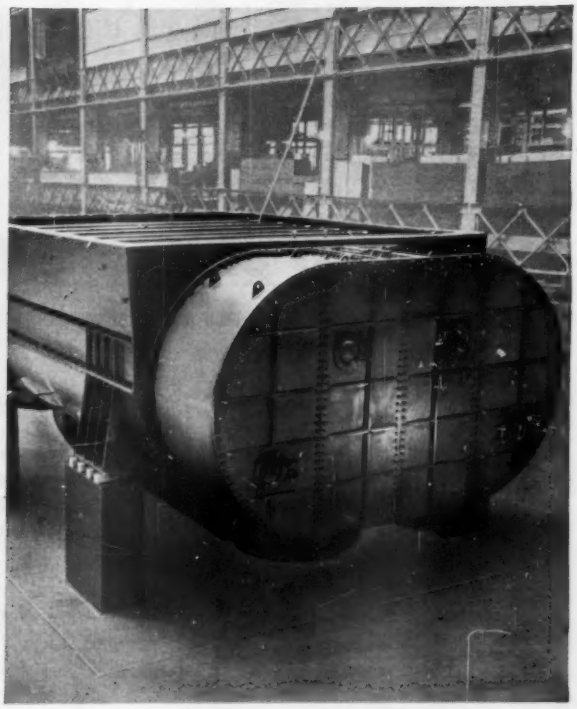


One of 28 Worthington condensers serving 20,000 kw turbine generator units in a southern aluminum plant. Each unit has twin 9300 sq. ft. shells, tee-connected.



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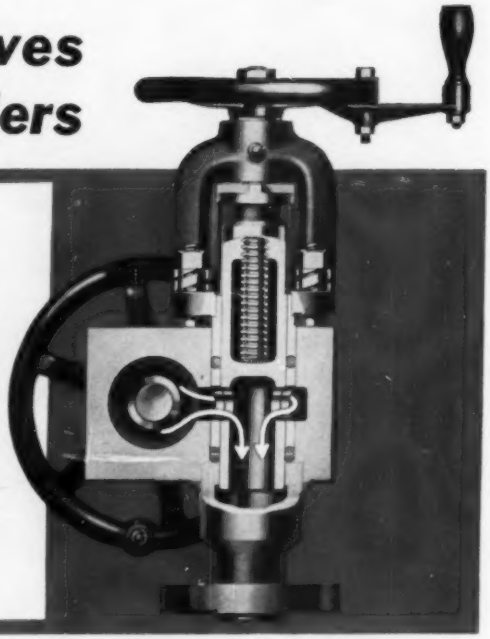
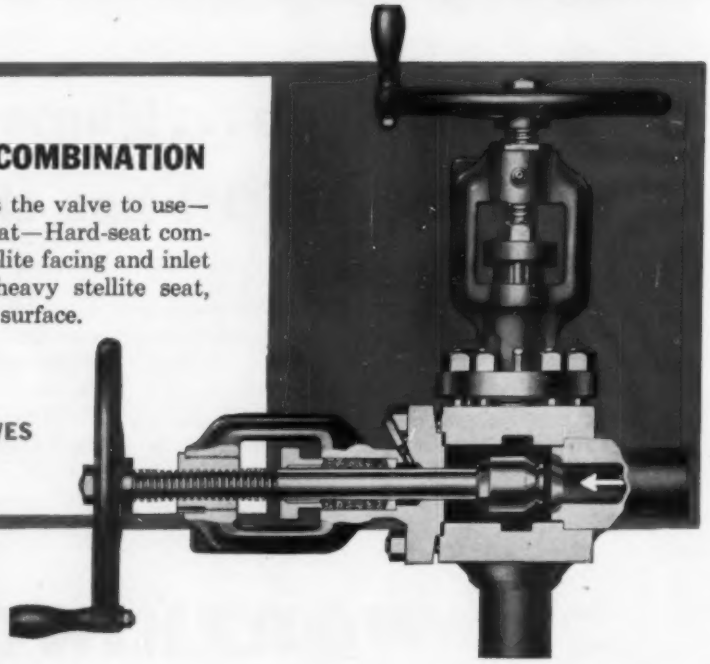


HARD-SEAT—SEATLESS COMBINATION

■ For boilers up to 1500 psi, this Yarway Unit Tandem Blow-Off Valve offers the maximum in dependable service. A one-piece forged steel block serves as the common body for the Yarway Stellite Hard-seat blowing valve and the Yarway Seatless sealing valve. All interconnecting flanges, bolts and gaskets are eliminated. The Unit Tandem at right is sectioned through Seatless Valve to show balanced sliding plunger in open position and free flow.



HARD-SEAT—HARD-SEAT COMBINATION

■ For boilers to 2500 psi, this is the valve to use—Yarway's Unit Tandem Hard-seat—Hard-seat combination. Disc has welded-in stellite facing and inlet nozzle has integral welded-in heavy stellite seat, providing smooth, hard-wearing surface.

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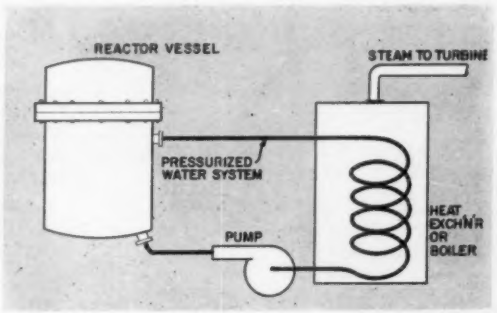
Construction of Shippingport Reactor Vessel Completed

Impressive ceremonies marked the completion and shipment of the reactor vessel for America's first nuclear power station at the Chattanooga plant of Combustion Engineering Inc where this fabrication job was accomplished. Built with steel walls 8½ in. thick and involving many special features, the construction of this important vessel was perhaps the most difficult fabrication job ever accomplished.

HEAVIEST SINGLE component for America's first full-scale commercial nuclear power plant, the shell of the 235-ton reactor vessel for the Shippingport Station of the Duquesne Light Co, was shipped from the Chattanooga, Tenn., plant of Combustion Engineering, Inc, on September 25. On hand to inspect Combustion's new facilities for the manufacture of heavy nuclear components and to witness the loading of the heavy vessel were representatives of the Atomic Energy Commission, government officials, many utility and business executives and members of the technical press.

This reactor vessel involved perhaps the most difficult and painstaking fabricating jobs ever undertaken by any group of engineers and workmen. It was built by assembling sections of the heaviest clad plate ever rolled by Lukens Steel Co., and by developing special welding and heat-treating techniques at the Chattanooga shops of Combustion Engineering, Inc. The formidable problems involved in the design, development, and manufacture of this very heavy, yet extremely precise, vessel were solved by close coordination between Combustion, Westinghouse and AEC engineers.

Fig. 1. Diagram showing how the reactor vessel is used in the Shippingport plant. Water under a pressure of 2000 psi is circulated from the vessel through a heat exchanger where steam is generated for use in an ordinary steam turbine



Numerous problems involved required reliance on fundamental theory. Accepted formulas for determining stresses and thickness were no longer applicable in a vessel with the thicknesses of plate and forgings involved. In addition to pressure and thermal stresses due to start-up conditions, consideration had to be given to the heat generation in the vessel wall resulting from neutron and gamma ray flux emanating from the nuclear fission process. As a result of the design, development and manufacture experience on this reactor vessel, it is believed that new criteria and new formulas will be standardized in order to facilitate future design of this equipment.

To those who may not be familiar with the purpose of this vessel, the diagram shown in Fig. 1 may be helpful. This shows how the vessel is used in the Shippingport plant. It is merely a tank to hold the nuclear reactor in which heat is generated by the process of nuclear fission. In an ordinary fuel-fired steam power plant, heat is supplied by the combustion of coal, oil, gas, or other fuel. In a nuclear power plant the heat is supplied by the nuclear reactor.

This heat has to be removed from the reactor by some heat exchange medium. In the case of the Shippingport system, this is done by circulating ordinary water through the reactor under very high pressure so that the water will not boil. At Shippingport, this water will be under a pressure of about 2000 psi.

By means of pumps this water is circulated through the nuclear re-

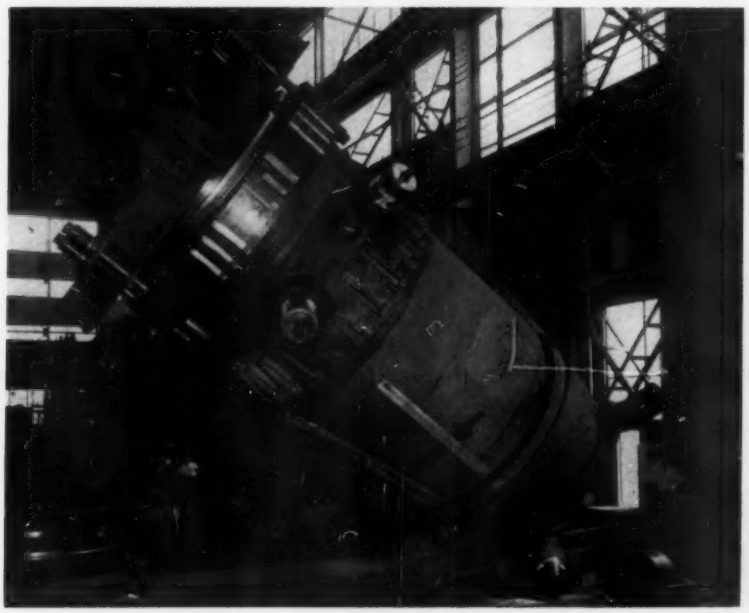


Fig. 2. Shell of the 235-ton reactor vessel designed and built by Combustion Engineering for the Shippingport nuclear power plant. This photograph shows only the shell without the top head. This shell weighs 150 tons. The top head, 85 tons. The walls of this vessel are 8½-in. thick clad steel

actor located in the pressure vessel and out to a heat exchanger which functions as a steam boiler. In this heat exchanger, the high temperature (around 550 F) pressurized water gives up its heat to the water in the boiler, thereby converting it into steam for use in a steam turbine. This is all there is to it. It is quite simple in principle.

In practice, however, the job is extremely difficult, first because of the very high water pressure involved, and secondly because of the extremely high concentration of energy release in the reactor. The amount of energy release in this reactor vessel, which measures roughly 31 ft in length and 9 ft in diameter is equivalent to some 250,000 kw! The steam produced will drive a 60,000-kw turbine generator.

Very high temperature of the water at 2000 psi makes it necessary that the water be of extremely high purity, but since pure water at such pressures and temperatures is highly corrosive, it was essential that the interior of the vessel be of stainless steel. Thus, the internal portions are clad with a ¼-in. minimum thickness of stainless steel.

The vessel is designed to withstand a 2500 psig internal pressure at 600 F. At rated load 26,000,000 lb of primary coolant water will pass through the vessel each hour through 4 inlet nozzles. In the vessel the water temperature will be raised from 507 F to 542 F.

Dry weight of the vessesl is 235 tons, of which the shell (shown in the photographs) weighs 150 tons and the removable top head 85 tons. The top head is fastened to the shell section by means of 42 six-in. diam studs, 80½ in. long. Each stud with its accompanying nuts weighs 700 lb. To secure the head to the vessel, these studs are elongated by heat supplied from electric heaters extending into the center of the studs so that the nuts can be turned through a predetermined angle to induce the required stud tension when the studs cool to ambient temperature.

The hemispherical bottom head and shell courses were fabricated from manganese-molybdenum clad plate having 6-in. and 8⅜-in. minimum thicknesses respectively. These integrally clad plates were fabricated by Lukens Steel Co. The walls of the shell are 8½ in. thick including the ¼-in. cladding. The removable head has its hemispherical portion penetrated by 46 openings in which are attached housings which allow entrance of fuel handling equipment for removing spent fuel elements, instrumentation leads, and control rods.

Fig. 3. View of the bolts for holding the head to the main vessel. There are 42 such bolts 80½ in. long, 6 in. in diameter, and weighing 700 lb each, including the nuts

To assure proper functioning of the control rods, the over-all alignment from the top of the control-rod housings to the core assembly was held to less than 0.011 in. per ft. In short, this huge vessel is made with the precision of a watch.

Some idea of the problems involved can be gained from the fact that the parts making up the vessel were the biggest and heaviest of their kind ever made. Particularly difficult was the problem of getting the very heavy and thick clad plates with an integral bond between the clad and backing plate.

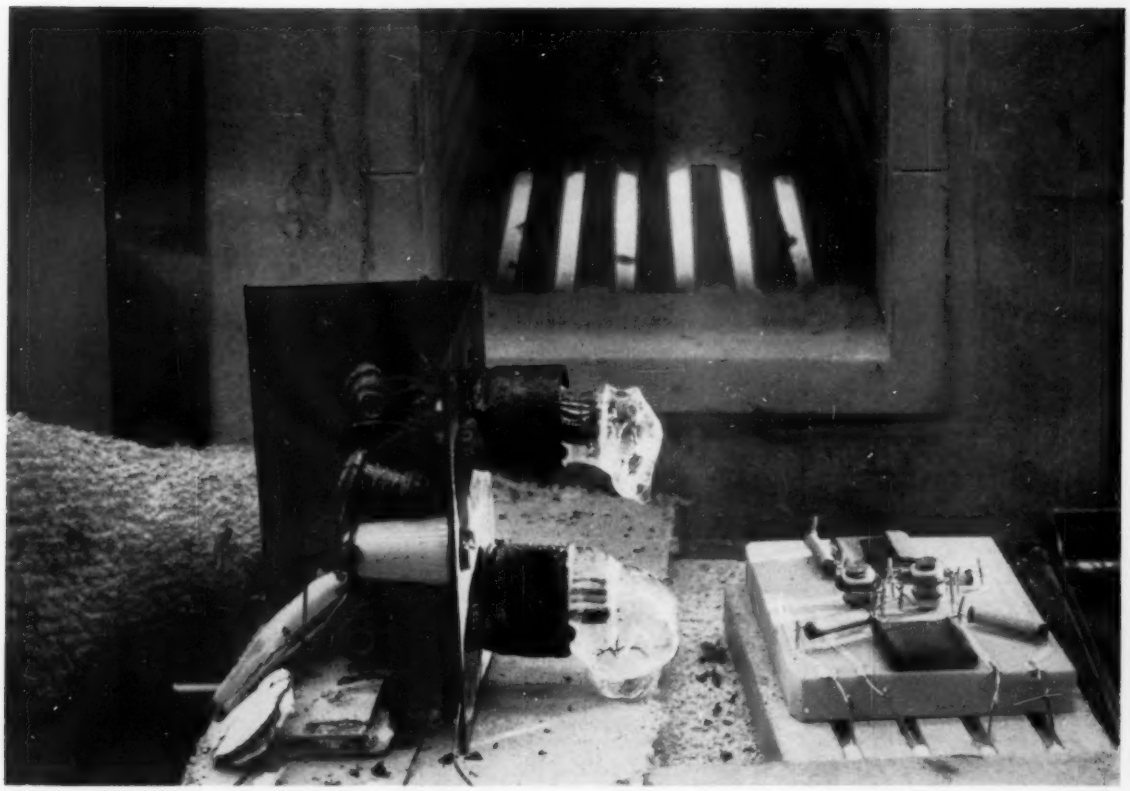
This was the largest plate of this type ever rolled by Lukens Steel Co. The plate, after being rolled, was examined over every square inch of its surface by the ultrasonic method of inspection. The flanges for the vessel and heads presented difficult alloy-forging problems which were finally solved by Bethlehem Steel Co. These are the largest manganese-molybdenum steel forgings ever made.

Forming of the shell involved the maximum 6000-ton capacity of the Combustion Engineering hydraulic press equipment. Welds were X-rayed by means of a 15,000,000-v betatron — the sensitivity being such as to detect no larger than a ⅛-in. length of toothpick embedded in a 10-in. weld deposit.

Over-all fabrication of this vessel involved a time period of about 16 months. Much of this work progressed 7 days a week, 24 hr a day, with time out only for special holidays. Final machining of the shell took 60 days, round the clock, 7 days a week. Optical methods were used to align various machine surfaces to give the highest possible accuracy. A new gas or oil-fired, 250-ton capacity car type furnace for heat-treating vessels up to 19 ft diameter and 58 ft long, was engineered and built by the Combustion Engineering staff.

Extreme weight and size of the reactor vessel were a source of many problems in finding a suitable way to ship it from Chattanooga to Shippingport. Barge transportation proved not feasible, so it was transported on a special 24-wheel flatcar by rail. It is interesting to note that the airline distance from Chattanooga to Pittsburgh is approximately 365 miles, whereas the vessel itself traveled a distance of 1075 miles.

Fig. 4. View of the reactor vessel on a special 24-wheel flat car showing the heavy manganese-molybdenum forged steel flange. This is the flat car on which the vessel was transported to the Shippingport plant



Comparison between conventional and new high temperature circuits after being placed in an electric oven at 1500 F

Electronic Components Operate at 900 F

MAXIMUM TEMPERATURE at which most electronic components today will operate for prolonged periods is around 200 F. Due to the exceptional military demands of World War II, several components were developed that could operate at 300 F. Now General Electric Co has announced production of components and basic circuits capable of operating at 900 F and more.

At a recent demonstration to show the versatility of these electronic components, G-E Research Laboratory scientists played a phonograph which reproduced a jazz record with the amplifier glowing brightly in a 1500 F oven. The photograph illustrated here shows a comparison between an ordinary electronic circuit that failed almost immediately in an electric oven at 1500 F, and the new high-temperature circuit that operated satisfactorily for thousands of hours at the same temperature.

Following is a brief description of methods used to enable various components to stand such temperatures.

Electronic Tubes: Tubes for high-temperature operation are made of ceramics instead of glass, and most of the metal parts are made of titanium, a metal that tends to absorb gases rather than evolve them under conditions of high temperature and high vacuum. Such tubes can operate at temperatures up to 1450 F. They can be made to operate without heater power at 700 F and above.

When these tubes use titanium grids and passive cathodes, they can be made to give a built-in bias of up to 2 volts, so that no grid battery is required. They have shown stable characteristics for many thousands of hours on test and they may well be the forerunners of a reliable and unique class of tubes.

Resistors: For operation at temperatures up to 1450 F, resistors consist of hollow ceramic tubes, with the internal surfaces covered with a resistance coating. The tube is sealed under vacuum by two titanium caps which make electrical connection with the two ends of the resistive film. Recent laboratory work has developed newer surface films capable of producing resistors with values up to several megohms at 1000 F.

Capacitors: Most conventional dielectric materials such as quartz are no good for high temperature operation because their losses become too great. The majority of micas crumble above 950 F, but it was found that certain domestic micas were not subject to such disintegration when heated; and further, that the low frequency resistivity of the material was increased by such heat treatment. On the basis of such measurements, capacitors have been produced which will operate successfully at temperatures as high as 1450 F.

Wire: Ceramic coated wire has been produced for use in transformers, motors, inductors, and alternators. A clad copper wire is coated with a high-temperature glass which provides protection from oxidation and also provides electrical insulation at working temperatures up to 950 F.

Circuits: Recent work at the laboratory has utilized printing techniques of metallic silver bonded to a ceramic base. Component mounting supports are provided by having platinum wires embedded in the ceramic at connection points. This enables components to be spot welded in position and changes to be made even after operation of the circuit for long periods of time at 1200

F. Since the platinum does not oxidize, spot welding or high-temperature brazing to such points is always possible without elaborate prior surface cleaning.

Transformers: Common coil conductors, magnetic materials and insulations change radically at high temperatures. For example, common copper conductors are rendered useless by progressive oxidation; common magnetic steels lose their magnetic properties, and the resistance of inorganic insulating materials drops to marginal values. In contrast to these conventional materials, the high-temperature transformers utilize magnetic steel which maintains its properties well above 1000 F, silver and nickel-clad copper conductors, and ceramic insulations.

Motors: A small motor has been developed that operates at a temperature of 900 F. Solder melts, and water turns to steam as soon as it comes in contact with the case of the motor when in operation. The motor uses a new ceramic stator insulation, silver rotor conductors, and nickel-clad wire. The motor is two-phase, and operates at 400 cycles and 57 v. It has 2 in. diam, is 3½ in. long. Stators and rotors of similar construction have been operated successfully for 1000 hr at 900 F.

It should be emphasized that all the devices described above are laboratory models, and though completely workable, are not in production at the present time.

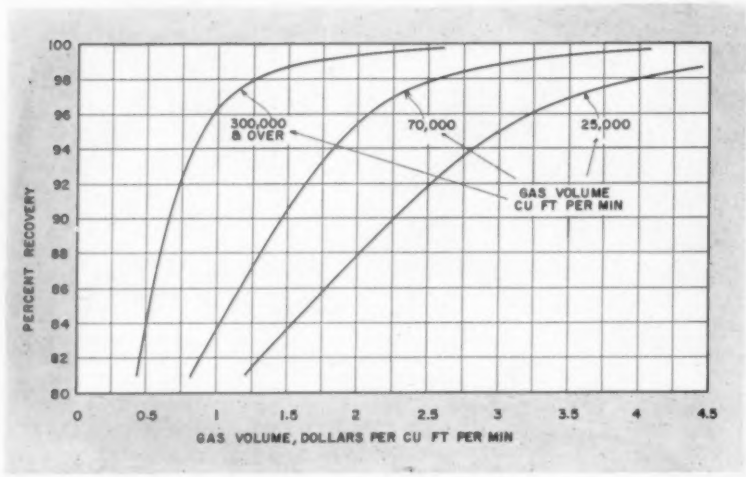


Chart for estimating electrostatic precipitator costs for various gas quantities

Just What Do Electrostatic Precipitators Cost?

IN ITS SIMPLEST FORM, an electrostatic precipitator consists of a wire electrode with a negative charge of 40,000 to 75,000 volts and a grounded plate 4 to 6 in. from the wire. The high voltage is obtained by stepping up a-c plant voltage in a transformer and then rectifying it to d-c.

The high voltage breaks down the atmosphere between the wire and the plate, starting a transfer of negative ions from the wire. When a gas containing liquid or solid particles passes between the wire and plate, the particles pick up ions and the charged particles move to the grounded plate where they lose their charge. The particles form an agglomerated mass on the collecting plate, and this mass is dislodged by rapping the plate, and falls into a receiving receptacle.

Some interesting figures on equipment and operating costs for electrostatic precipitators were given by E. P. Stastny, of Koppers Co. Inc. in a recent issue of *Chemical Engineering Costs Quarterly.*

As Mr. Stastny pointed out, it is difficult to generalize about the cost of electrostatic precipitators because of the great variation in the precipitability of the material being collected. For the same gas volume, variations in cost of equipment of the order of 200 to 300 per cent are not uncommon between different applications handling different materials with different particle loadings and different efficiencies. However, the accompanying chart can be used to obtain a reasonable estimate of the cost of electrostatic precipitators to handle various quantities of gases with a loading of 2–5 grains per cu ft and with various recovery efficiencies.

These costs are for standard steel units. Special materials of construction to handle corrosive gases may increase the cost by as much as 100 per cent.

Power to energize electrostatic precipitators is generally considered to be negligible compared to power costs for other types of electrical equipment found in an average plant. For units handling 12,000 cu ft per min of gas, power consumption is approximately 5 kw; units handling 90,000 cu ft per min require approximately 30 kw; and units for higher volumes require about 35 kw per 100,000 cu ft per min.

To power electrostatic precipitators, packaged power packs are available. These units consist of two main components; the control section, and the transformer-rectifier section. Rectifiers can be of the electronic tube type, selenium, or mechanical.

Approximately once every three months, it is advisable to shut down the power pack for cleaning and inspection. This requires about an hour. Major components of the pack rectifier may require replacement at periodic intervals. These costs may range from $100 to $400 per rectifier per year, depending on the size of the rectifier and over-all installation.

Maintenance costs for electrostatic precipitators are very low. Occasionally the alignment of electrodes within the precipitator must be checked, but inspection for correct alignment is usually done only once a year during the regular yearly shutdown for plant maintenance.

Electrostatic precipitators have very low draft losses. Pressure drops through precipitators range from 0.25 in. to 0.50 in. water. Power for induced-draft, or forced-draft fans for overcoming draft losses, costs approximately $5,000 per year per in. water drop per 100,000 cu ft per min based on a 1 cent per kwhr power cost.

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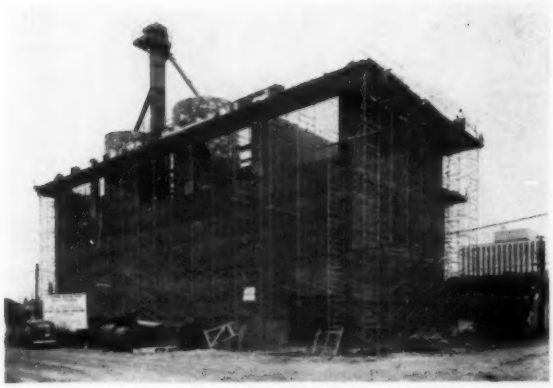
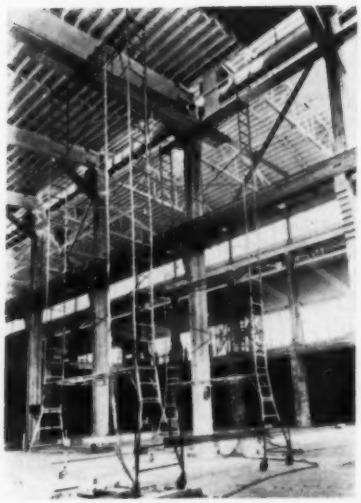


Fig. 1. Tubular steel scaffolding erected for construction of central heating plant in Tennessee. This type of metal scaffold can be put together as needed from standard units. Such equipment increases safety, replaces old-style lash-ups

Modern Scaffolding Is Versatile . . . . Gives You a Long Reach



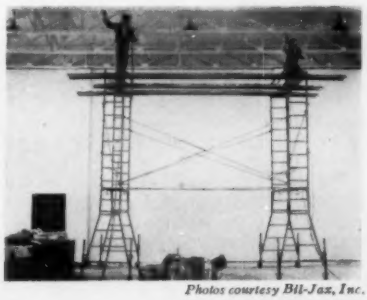
For some of the jobs you have to do, nothing takes the place of scaffolding. Luckily, the inventiveness and ingenuity shown by the makers of modern metal scaffolding give you a wide choice of material and design from which to choose equipment most suitable for you. Assemble your own set-ups with versatile standard units

Fig. 2. (*Left*) High-reach scaffold has metal catwalks and casters for mobility

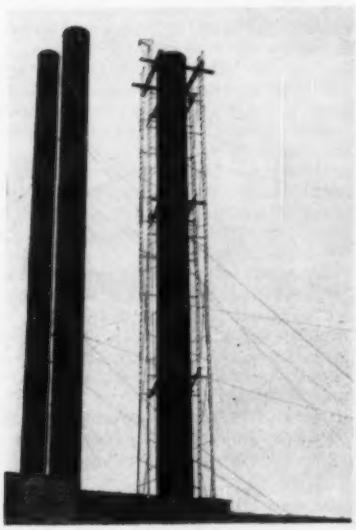
Fig. 3. (*Right*) Maintenance scaffold gives mobility, safe working platform. When work is completed, scaffold can be disassembled, stored in small area

Fig. 4. (*Below, left*) Stack repair and maintenance speeded by scaffolding

Fig. 5. (*Below, right*) For those hard-to-reach spots over turbines or other equipment, beam scaffold is answer; simply hook it on I beams or girders



Photos courtesy Bil-Jax, Inc.



Maintenance Is a Business—Make It

Author suggests positive rather than negative approach to problem of maintenance and tells why and how of his program. This first article explains the *why*—second article will describe the *how*

By CHARLES T. MAXWELL, Jr.*

MAJOR PRODUCTIVE function of the electric utility central station is to produce a determined amount of electrical energy at the lowest cost consistent with the highest standards of reliability.

Since much of the responsibility for the preservation of these high standards of reliability is assigned to the maintenance department — along with a considerable portion of the responsibility for the level of over-all costs — a successful maintenance program is vital to this purpose.

This program must be a well-ordered, positive program, with the objective of preserving the top physical condition, quality, and capability of each item for which the department is responsible.

Establishment of a central station maintenance program must be undertaken only with a thorough knowledge and understanding of principles which must be embraced, problems which may be encountered, and results which may be anticipated. An accurate evaluation of the program's true function in the power plant is essential. Maintenance merits a *positive* approach.

Maintenance is as much a tangible in a power plant as equipment and fuel, as much a productive entity as operation itself. Unfortunately, through the years, utility men have become prone to speak of the maintenance "problem," and their approach is all too frequently negative. Even the term preventive maintenance represents a negative attitude, for it seems to regard the function as protective rather than productive.

From the time a piece of equipment is released for operation in a central station, its condition is the responsibility of the maintenance department, except for operating care and wear. In virtually all cases, a machine is at its top physical condition at the time of its release. It therefore becomes the responsibility of the maintenance department to retain, or, to return the item to this condition following regular periods of normal operational wear.

Retained in top condition, there is minimum likelihood that a machine will be a cause of trouble; rather it will increase the efficiency of electric production, lowering the cost of kilowatthours. Thus, *retentive*, as contrasted to *preventive* maintenance, makes a dual direct contribution to the purpose of the plant.

Any tendency to cut over-all costs by cutting the maintenance budget should receive careful attention. Sound management has long recognized that, frequently, by purchasing more expensive fuel the over-all cost of kilowatthours may be reduced, but the idea of the analagous situation with respect to maintenance expenditure has in many cases yet to be sold. Factual information, derived from the maintenance program, is necessary to make this sale.

The maintenance department has a product, which it produces for a market, and therefore must adhere to certain managerial principles common to all productive organizations. The product in this case is efficient, reliable machinery and equipment, but the market is not insatiable. Therefore, to take its proper place and perform its proper function, the maintenance department must be organized and operated in the same manner as any other producing, profit-making organization. Its size will be controlled by the quantity of its product which will be consumed without saturating its market; it must operate somewhat below the point of diminishing returns. Facts must be made available to determine this point.

Andrew Carnegie's fundamental approach should be kept in mind: "Analyze, Organize, Deputize, Supervise." The program must provide material assistance in each of these steps. Measures of their effectiveness are essential, and the detection of contributing factors must be a part of the program.

Continuing replacement of maintenance equipment with improved and more efficient models, and the provision for well-trained manpower replacements must be governed by the program.

Above all, the maintenance department must coöperate and coördinate with the operating and other departments in the plant; the plant in turn must coördinate with other plants and other divisions within the company; the company in today's modern power systems must coördinate with other companies. The maintenance program must both contribute to and be controlled by this interlocking coördination.

Maintenance work in the central station is necessarily broken down into four distinct categories, which may be defined as follows:

1. **Scheduled maintenance** is work performed according to pre-arranged plan.

2. **Emergency maintenance** is work done as a result of the failure of any item to perform its function, in order to restore the item to its proper condition with the least practicable delay, if such failure directly or indirectly decreases the capability or reliability of the station.

3. **New construction** is work done by the maintenance department under Construction Work Orders, or other capital designation, including the fabrication, installation and/or placing in operation of any item or system.

4. **General maintenance** includes work done on a routine basis, minor repairs, minor construction, miscellaneous shop work, etc.

It should be the early concerted effort of a maintenance department embarking upon a RETENTIVE MAINTENANCE program to increase the amount and detail of scheduling, as a result of which it may be expected that the amount of emergency work will be decreased. In order to prepare intelligently an intensified maintenance program, however, it is necessary to accumulate records providing information on past experience, the present condition of all items to be scheduled, and the expectancies in manpower, to be ap-

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Produce! Part I

portioned to the various categories of work.

Such records, when assembled, will serve not only to aid in setting up the program, and its subsequent evaluation, but will also provide an accurate history of each item of plant and equipment.

We shall discuss in some detail the important aspects of the categories of work and their relationships, and present in a tentative form the technique of accumulating data. Efforts to streamline such technique, once adapted to a given plant, and to eliminate the accumulation of extraneous material, must be continual. The routine of the process may be so simplified that the work may be accomplished quickly, and by clerical rather than technical personnel.

Scheduled Maintenance

Scheduled maintenance is the backbone of the entire maintenance program. Its success depends upon the skill of maintenance management in analyzing all of the factors involved in the complex problems of scheduling, evaluating these analyses, and integrating the results into a whole program. Properly planned, organized, and executed, scheduled maintenance forestalls all of the potential undesirable results of emergency breakdowns (see below). It is an indispensable tool of good plant management.

In retentive maintenance of the proper caliber, a plant is operated not by a series of crises, frequently at reduced capacity or dangerously near it, but as a well-ordered, reliable, productive function in which the employee, the management and the community alike take pride.

The approach which looks toward the minimum amount of preventive maintenance necessary to hold the breakdown of essential items within the limit of getting by has proved to be the cause of the failure of many programs. This approach fails to prevent many of the undesirable results of breakdowns, for it does not take into account the inevitable depreciation of plant and equipment, a factor which must be effectively combatted by the successful program. A program initiated with such an attitude will be forced backward and doomed to failure, for it does not serve the basic purpose of the plant.

The complexity of scheduling the maintenance of the intricate machin-

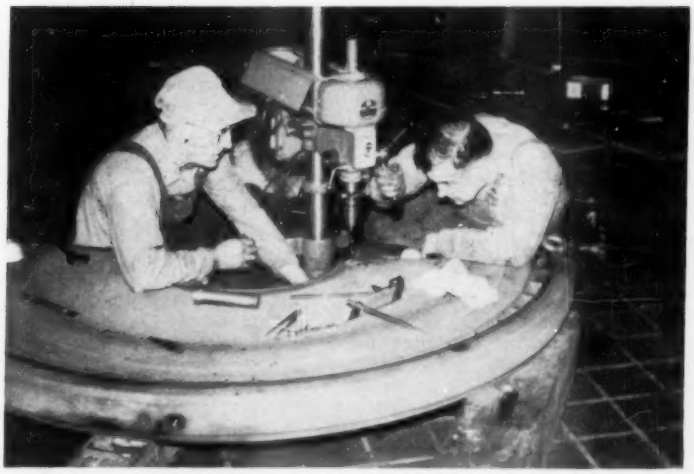


Fig. 1. Repair to turbine diaphragm is part of day's work for this maintenance crew. Important part of such repairs is method of planning and scheduling

Fig. 2. Shrouding on turbine rotor gets attention during outage. Work like this should be regarded as *retentive*, rather than preventive maintenance

Fig. 3. Natural hazards like this flood cannot be guarded against by even the shrewdest planning, but good basic organization can minimize disaster

ery, systems, and combinations of the modern plant is sufficient to challenge the combined knowledge, experience, and resources of operator, mechanic, engineer, manufacturer, and management, and such scheduling should not be attempted without the contributions of all of them, as well as in some cases the consultation of the installer or erector.

Manufacturers can usually furnish records of the experience of others with similar items, as well as their own recommendations for proper maintenance. The engineer can furnish data on materials, lubricants, stresses, structures, temperatures, etc. Scheduling outages affecting capability requires, of course, consultation with the operating department, as well as the approval of top management, and the same is true in lesser degree of outages which affect the reliability of the plant.

The experience of mechanics will provide much helpful information in the scheduling of maintenance. This aspect becomes particularly valuable in the absence of adequate historical records on past performances. Also from this source comes valuable help in estimating the number of manhours to be allowed for each inspection, one of the important phases of planning.

The factors to be considered in these discussions and analyses are multifold and complex. The judgement used in evaluating the results and arriving at the eventual integrated schedule will help determine the success of the entire program.

Consider, for instance, in analyzing the factors influencing the scheduling of any one item, the multiplicity of relations involved in the effect on total capacity. Whether the outage of an item is on a scheduled or an emergency basis, the effect on total capacity of the station is usually the same.

The greater the effect on total capacity, the more important becomes the consideration of the effect of scheduled outages on the probability of emergency outages, the relative lengths and relative costs of the outages, and the effectiveness of other than major inspections. (It may often be desirable to schedule minor overhauls of equipment at lesser intervals than major, specifically enumerating the steps to be accomplished during these services.)

The factors that influence decisions, most of them implying comparison of emergency and scheduled outages, are listed in the accompanying table. Also shown in the table is an example of the application of these factors to the case of a bowl-type coal pulverizer.

The set of responses to the considerations set out in the table, although applicable to the pulverizer, would probably not be applicable to any other piece of equipment in the plant. Each class of machinery — indeed, often each unit — must be considered separately since each is ruled by a unique set of circumstances.

In some cases there is considerable relief from much of the intricate scheduling duties at the plant level since major outages are scheduled on a network basis, and many of the minor items are automatically scheduled in conjunction with the major outages.

Emergency Maintenance

With rare exceptions, emergency maintenance is the least desirable type of maintenance work. It is usually the result of the actual or imminent breakdown of some piece of equipment or part of a system. Such a breakdown may result in:

1. Critical emergencies
2. Injuries or fatalities among personnel
3. Brief or prolonged outages
4. Injury to other equipment
5. Decreased capacity
6. Decreased reliability
7. Adverse public relations
8. Poor labor relations
9. Great material losses
10. High equipment costs
11. High labor costs

The percentage of time which a maintenance crew finds necessary for emergency maintenance is an excellent barometer of the success of its scheduled maintenance. The vast percentage of breakdowns show, when the cause has been determined, that properly scheduled inspection and maintenance could have detected the weakness and forestalled the interruption in service.

In order to determine the extent and effect of emergency maintenance on the activities of the maintenance department, it is necessary to isolate and record all time spent on work of this category. These records are also necessary *continued on page 131*

Table shows factors involved in comparison of emergency and scheduled outages

Factors affecting equipment maintenance schedule	How factors apply to bowl-type coal pulverizer
1. Effect of outage on total capacity	1. Either scheduled or emergency outage would have same effect on capacity. If boiler concerned also burns gas, effect on capacity may be seasonal
2. Effect of outage on station reliability	2. As above, except seasonal effect may be more pronounced
3. Probable length of outage	3. Scheduled outage can be estimated, emergency probably not. Properly administrated scheduled maintenance will tend to limit severity, and thus length, of emergency outages
4. Probable cost of outage	4. As above
5. Effect of inspections on operation and efficiency	5. Scheduled overhauls definitely affect the operation and efficiency of these mills. When worn, do not respond well to control demands varying with load fluctuations; power consumption rises, combustion efficiency is decreased, thus raising kwh cost
6. Effect in terms of eleven undesirable results of emergency outage (see text)	6. Mills not properly maintained susceptible to most of these undesirable results
7. Effect of major inspection on emergency outage probability	7. Mills not subject to emergency outages; outages infrequent, almost nil if scheduled maintenance is reasonable
8. Effect of other inspections on emergency outage probability	8. As above. Overhauls usually divided into two classes or more, only the major involving the mill drive
9. Maintenance time available and/or obsolescence of item	9. Is time available without robbing something more demanding? Interval here could be increased up to a third above ideal if necessary
10. Expected variation of load; seasonal, weekly, daily	10. If gas is burned, best time may be summer. If not between peaks, or during outage of boiler
11. Effect of season on performance of maintenance (exclusive of load)	11. Is department loaded with summer work?
12. Effect on probable life and/or obsolescence of item	12. Timely renewal of liners, thrust bearing, and other parts conceivably affects the life of the unit. Alterations may prevent obsolescence, but this probably would not be concerned with timing of overhauls
13. Replacement cost of item or parts	13. Replacement of item is prohibitive, parts relatively cheap. Replacement of liners prevents more expensive damage.
14. Availability of replacement or replacement parts	14. No effect

Nikola Tesla Honored at AIEE Meeting

Dr. Samuel Hibben demonstrating some of Tesla's high-frequency experiments at General Meeting of AIEE at Chicago

AMONG THE MANY interesting features of the Fall General Meeting of the American Institute of Electrical Engineers during the week of October 1, was the opening general session highlighting the accomplishments of Nikola Tesla, this year being the 100th anniversary of the inventor's birth. In a demonstration lecture, Dr. Samuel Hibben, noted lighting consultant, told of discoveries and inventions by Tesla in the field of high-frequency alternating current. At this same session, R. C. Sogge of General Electric Co., told about the four-day Tesla celebration in Belgrade, Yugoslavia last summer.

While much of Tesla's later life was spent in experimenting with the production and effects of high-frequency currents, his invention of greatest practical significance to the electrical industry was the polyphase induction motor. This involved a completely new conception of a magnetic field — one that revolved while the magnetic structure producing it remained stationary.

The simplicity of this motor had considerable influence in stimulating the use of alternating current for the transmission of electrical energy. Tesla did not, however, *invent* this type of electrical generation or transmission, nor is it realistic to claim, as some uninformed writers and news commentators on the radio have done, that our present great power system development would not have occurred without Tesla.

Every electrical engineer who knows something about the history of technical development, knows that the time for the invention of the polyphase induction motor was ripe, and that if Tesla had not conceived the idea someone else would have sooner or later. This is not detracting from any honor due to Tesla. The first use of alternating current had been made by Zipernowski and Deri, and Gaulard and Gibbs in Europe and by William Stanley in the United States. These, however, were single phase systems.

Tesla was the first to conceive the idea of a polyphase system and in this, and in his invention of the polyphase induction motor lies his great contribution to the electrical industry. Nothing can detract from that. He also contributed numerous new ideas for the design of generators, transformers, induction coils, arc and incandescent lamps, some of which proved practicable, others not.

Like many other inventors Tesla pursued blind alleys. One of these was his effort to develop a steam turbine without blading, an attempt to make use of the principles of adhesion and viscosity in turning a rotor. This never proved practicable. Nor did his idea of illuminating large outdoor areas by ionization of atmospheric gases by high-frequency electric fields ever materialize.

Tesla was a strange genius. As in the case of many other geniuses, Tesla's greatest inventions were made when he was still a comparatively young man, and these inventions were also the most fruitful from the standpoint of monetary return. It is said that he was a millionaire by the time he was 40 — largely the result of his invention of the induction motor and the polyphase system of transmission. Yet he died alone in obscurity and in comparative poverty in a New York hotel in 1943.

Wireless Transmission of Power

He was a great visionary. He had many ideas which he never carried out but which were later utilized by other inventors. His flashing insight and the wide range of his thinking made him impatient with the practical world and he was largely indifferent to the development of his ideas. Listen to his comment concerning the "Transmission of electrical energy without wires as a means for furthering peace," as reported in the *Electrical World and Engineer* in January 1905:

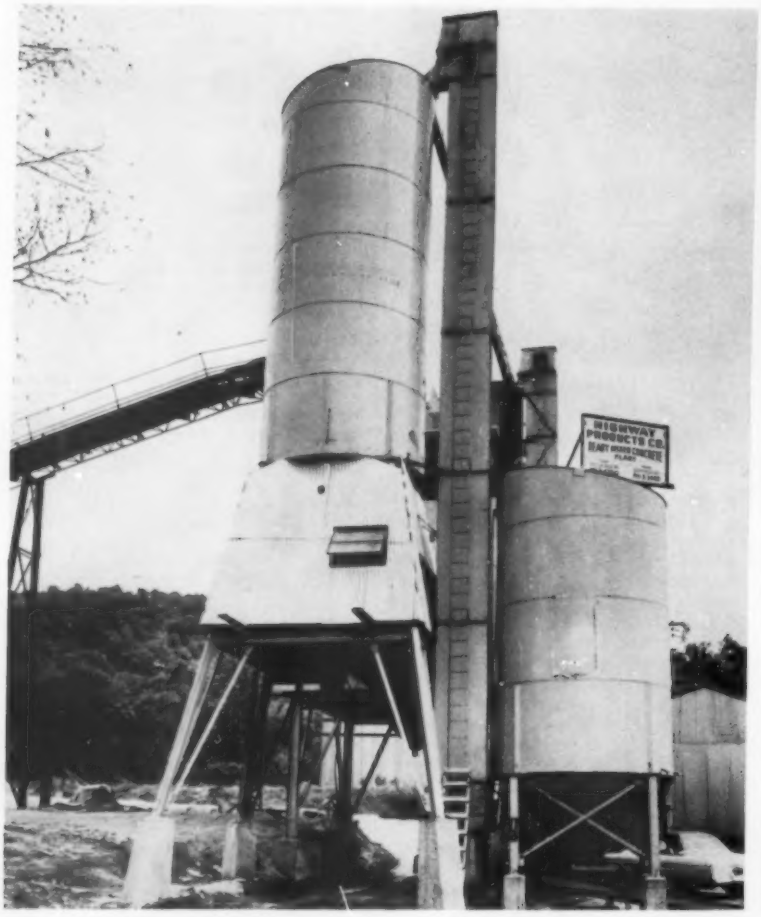
". . . It is not a dream, it is a simple feat of scientific electrical engineering, only expensive — blind, faint-hearted, doubting world! Humanity is not yet sufficiently advanced to be willingly led by the discoverer's keen searching sense. But who knows? Perhaps it is better in this present world of ours that a revolutionary idea or invention instead of being helped and patted, be hampered and ill-treated in its adolescence . . . by want of means, by selfish interest, pedantry, stupidity and ignorance; that it be attacked and stifled; that it pass through bitter trials and tribulations, through the heartless strife of commercial existence. So do we get our light. So all that was great in the past was ridiculed, condemned, combatted, suppressed — only to emerge more powerfully, all the more triumphantly from the struggle."

The whole of Tesla's impatient temperament is reflected in this quotation. In many ways he was an impresario — he had a sense of the dramatic and he was probably at his best in his lectures and demonstrations of his spectacular high-voltage, high-frequency experiments. Here he held forth like a Mephistopheles amid blazing, thundering cascades of sparks, often 30 ft long — Tesla currents alternating at such prodigious frequency (at that time) that they would not harm a kitten.

With all his achievements, throughout his life Tesla remained an enigma. He talked and wrote and created apparatus more as a poet than an engineer. Standing absolutely alone — having never joined a syndicate or corporation — he plunged along into the unknown world of high-frequency long before we were ready for that sort of thing. He seemed an arch-conspirator against the established order of things.

Dr. Adams McAllister of the Bureau of Standards said once that Tesla made a single great mistake: he was born a quarter of a century too soon. Whether that is true or not is of little consequence. The fact remains, Tesla made important contributions to the field of electrical engineering and his striking yet elusive personality coupled with his vivid fertile imagination gives the modern world something to think about — the thought suggested recently by Mr. Crawford Greenewalt — the uncommon man as the key to progress. Nikola Tesla certainly was an uncommon man.

POWER ENGINEERING'S NEWS REEL

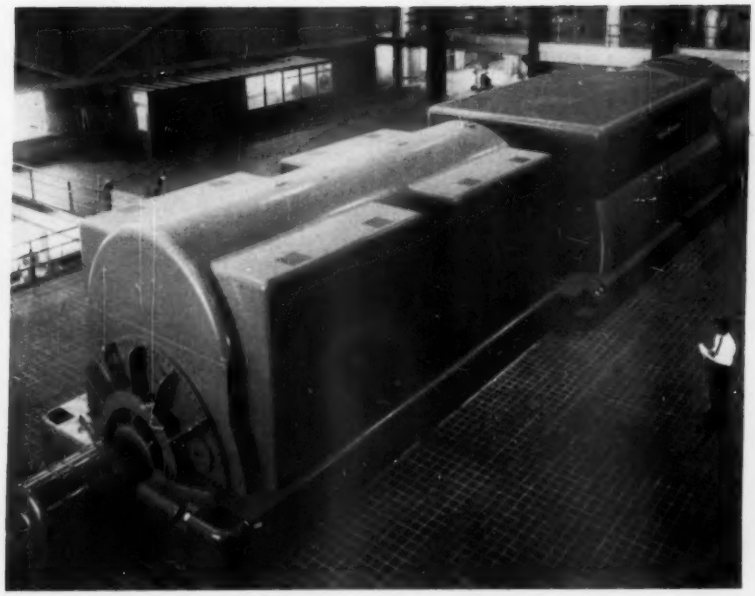


50-Curie Multitron (above), by the Budd Co, uses cobalt-60 to detect faults in atomic reactor shielding. Unit is equivalent to a 2,000,000-v X-ray

1500 Barrels a Day (left) from this Blaw-Knox portable cement plant went into Shippingport atomic plant during peak operation. Most of concrete should be poured by the year's end

Presentation (below) of AEC Commendation to Dr. Walter H. Zinn. At left, Dr. Kimpton, Chancellor of University of Chicago. Right, K. E. Fields, General Manager of the Commission

260,000 kva G-E generator (right) at Eastlake Station uses liquid cooling for stator bars. Method gives 75 per cent more kva than same sized machine with conventional hydrogen cooling

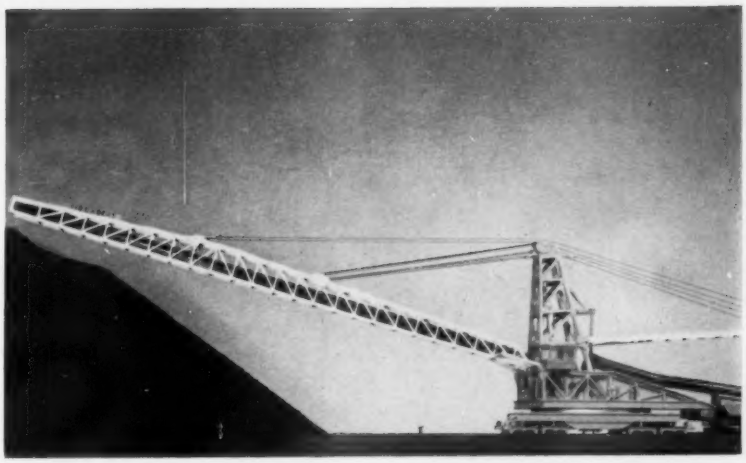


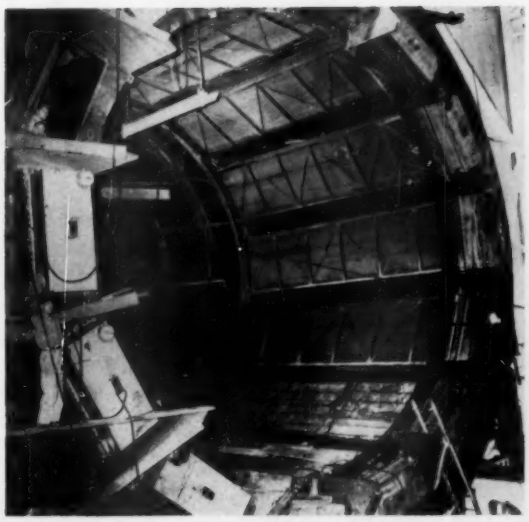
Continuous Inert-Gas (above), shielded arc welding process being used in Kaiser Aluminum Company's plant to weld an aluminum tank shell

Giant 275-ft Radius Link-Belt stacker (right) can stockpile 4,000,000 tons of taconite in a 90-ft high pile

World's Largest rubber-lined de-aerator (left, below), capacity 52,000 gal, for the Linden, New Jersey station

Cleveland Wind Tunnel cooler (right, below) will be able to handle 385,000,000 Btu per hr. Tunnel will have 250,000 hp electric motor drive





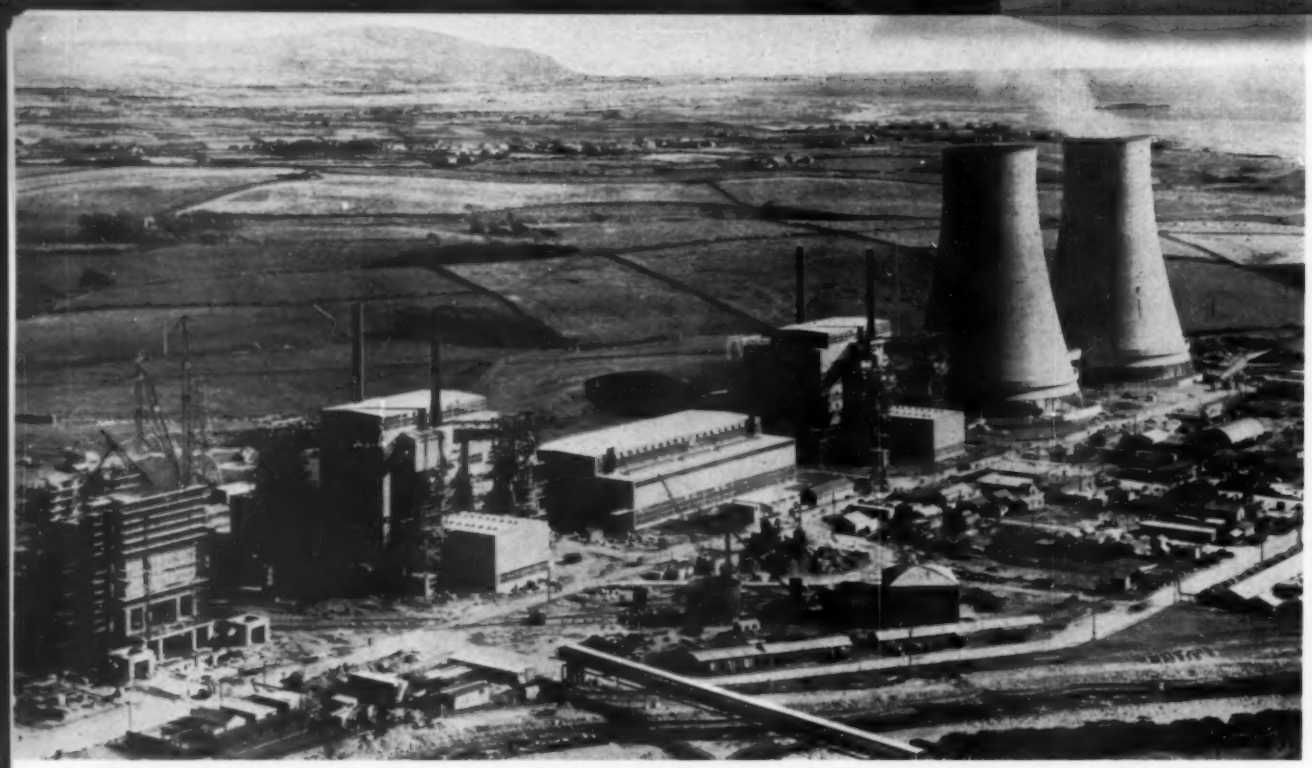


Fig. 1. View of Calder Hall from top of Windscale, nearby plant for producing plutonium from power plant's spent fuel

CALDER HALL—

Britain's Queen formally placed Calder Hall Station in service in October. This is the first of twelve large nuclear power stations England plans to build in the next ten years. By 1970 Britain expects to produce one third of its total electric power with nuclear plants

ON OCTOBER 17 Queen Elizabeth of England pressed a button which formally placed in operation the first *really large* nuclear power station in the world — the Calder Hall Station located in the bleak and craggy northwest corner of Cumberland in England.

Note, that we say, the first *really large* nuclear power station. Actually, the Russians placed a nuclear power station in operation on June 27, 1954 — over two years ago — but this was a 5000-kw plant, compared with the 60,000 kw which Calder Hall starts out with. By next spring Calder Hall is expected to be operating at a capacity of around 92,000 kw.

It must be understood, of course, that Calder Hall Station was built primarily as a plutonium producer. It is a dual-purpose station — it produces plutonium for use in nuclear weapons and, incidentally, power for use by the British Electricity Authority system.

There has been much loose comment recently by uninformed press and radio representatives concerning the *first* atomic power station. True, as early as December 1951, a token amount of electric power was produced at the Idaho Falls testing station of the AEC by using the heat from EBR-I the experimental breeder reactor. This was only a few hundred watts.

Other experimental reactors in this country have also produced small quantities of incidental electrical power but the fact remains, whether we like to admit it or not, the 5000-kw nuclear power station which the Russians built near Moscow, was the world's first atomic power station which was built solely for the production of electric power for peacetime use. Compared to Calder Hall and the nuclear power stations which we have under construction in this country, the Russian station is inefficient and the Russians are first to admit that fact, but it has been in operation for over two years, supplying power to the local community.

While the primary purpose of Calder Hall is to produce plutonium with the generation of electricity a by-product, it nevertheless is the world's first nuclear power station to produce electricity for national use, and at the ceremonies on October 17, power was sent into the British grid system for the first time.

The design of Calder Hall is simple and practical. It consists of two graphite-moderated, pressurized, gas-cooled reactors, each supplying two standard 23,000-kw turbine generating units. Because the primary purpose of the station is the production of plutonium for Britain's atomic energy program, the steam generating conditions are well below the optimum for power production.

The two reactors use natural uranium as fuel. The heat generated in the fuel rods is transferred in each case to four heat exchangers or boilers by carbon dioxide gas under pressure. Steam from the boilers is fed to the two turbine generating units. The steam cycle used is a dual pressure system involving the production of steam at pressures of 185 psi and 40 psi, respectively. When operating at rated load, the steam enters the turbine at 185 psi and 590 F, and a further supply at 40 psi and 340 F enters the turbine after the 15th stage.

World's First Large Atomic Power Plant Begins Operation

Calculation of the gas-cooled, graphite-moderated nuclear power plant cycle for the maximum production of electricity indicated that 65 per cent of the total quantity of steam needed could have been generated at a pressure of 400 psi, and the rest at 130 psi. The emphasis at Calder Hall, however, is on production of plutonium rather than electricity and the maximum thermal output from a given investment of fuel is desirable.

Accordingly, the coolant temperature rise in the reactor is required to be as high as possible and this in turn means that the temperature of the coolant leaving the heat exchangers has to be as low as possible since the upper temperature of the coolant is limited. It is, of course, possible to obtain this cooling by the addition of an after-cooler, accepting the waste of heat which this method would involve.

It is equally possible to obtain this extra cooling by appropriate selection of the dual-pressure cycle steam pressures, a method which does not involve waste of heat. Thus at Calder Hall the high and low pressure steam is generated at 200 psi and 60 psi, the optimum not for maximum station thermal efficiency but for maximum generation of electricity together with maximum production of plutonium.

Calder Hall is the first step in a 20-year nuclear power program which Britain hopes will provide enough electricity to save 20 million tons of coal — the amount by which her estimated coal production will fall short of estimated demand during the next 15 to 20 years. By 1975 Britain expects to be producing around 30 per cent of the total power used by nuclear energy.

The 12 nuclear power stations which the Central Electricity Authority is planning to build during the next 10 years, unlike Calder Hall, will be designed for maximum power output and will capitalize on the experience gained with Calder Hall. The use of higher temperatures in the reactor will yield more heat from the same amount of fuel.

Nuclear power plant development is moving fast in Great Britain. Another station, a duplicate of Calder Hall, has already been started adjacent to Calder Hall-A. The new station will be known as Calder Hall-B.

Across the Solway Firth at Chapel Cross, Dumfriesshire, in Scotland, work has been started on a slightly larger plant but also patterned after Calder Hall. This will be in operation in 1959. But quite a different project is under way some 300 miles further north in the Scottish County of Caithness which is about as far as one can go short of the Orkney Isles. Here, near a hamlet called Dounreay, a gleaming steel ball 135 feet in diameter is suspended some 35 ft above the ground level.

Inside will be a full-scale fast breeder reactor — one which creates more nuclear fuel than it burns. This probably will be the world's first fast breeder power plant because it is predicted that it will be in operation by 1958 or 1959, with a capacity of 60,000 kw. We are planning a fast breeder plant here in the United States but the British plant is expected to be in operation long before the U. S. plant is well under way. Adding up, these British nuclear power stations, within three years, will be supplying some 450,000 kw into the British power grid.

Britain has reason to push her nuclear program energetically. With limited coal and almost no oil or hydroelectric resources, her energy supplies are short. The Chairman of the British Atomic Energy Authority, Sir Edward Plowden, said in a recent speech in Washington, D.C., "There are compelling reasons leading us to work out this program when we did. They were economic reasons. They did not spring from any unique or spectacular advance in nuclear technology. Other countries also, I believe, will bring nuclear energy into commercial use when it is appropriate to their economic needs and economic resources."

On figures so far available, it is estimated that the total cost of power from Britain's early nuclear stations should be approximately the same as that from coal or oil-fired stations in England, which is about 0.6 pence a kilowatt. This figure is equivalent to 0.7 cents (7 mills) in U. S. currency, but no useful comparison with U. S. costs can be made because of the different circumstances in the two countries and the differences in depreciation and other accounting procedures.

The ratings of the first improved Calder Hall type stations to be completed by 1960 will be increased to 250,000–300,000 kw and that of the later Calder Hall type stations entering service in 1962 to 300,000–400,000 kw. A recent study shows that Great Britain's nuclear industry has a capacity to build between 8 and 12 additional nuclear stations over and above the 12 already projected during the next 10 years.

However, it should be remembered that it is because fuel costs are more expensive in England than in the U.S., that nuclear power can become competitive earlier in England than here.

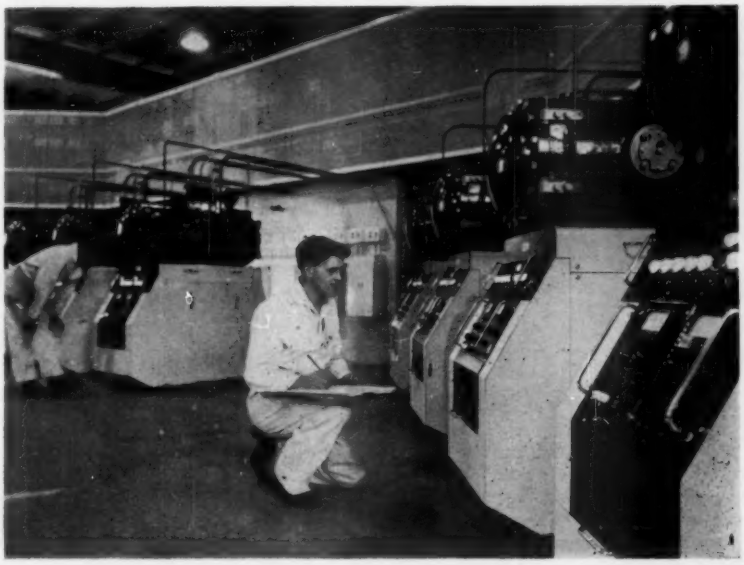


Fig. 2. Equipment for the detection of faulty fuel elements. CO_2 gas flowing through each of the 1500 fuel elements is systematically sampled every 30 minutes by this "sniffer" apparatus

This Is Calder Hall . . .

Fig. 3. (Right) the charging deck of No. 1 reactor. In the foreground are the control rod actuator mechanisms. In background is the charging machine

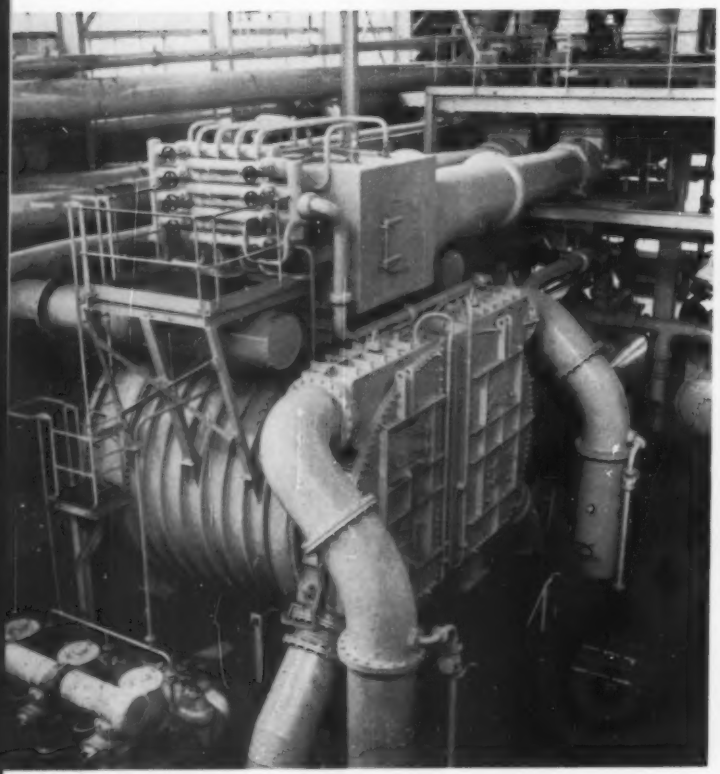


Fig. 4. Dump condenser, for condensing steam when it is not required for electric generation. This unit can condense the entire steam output from one reactor

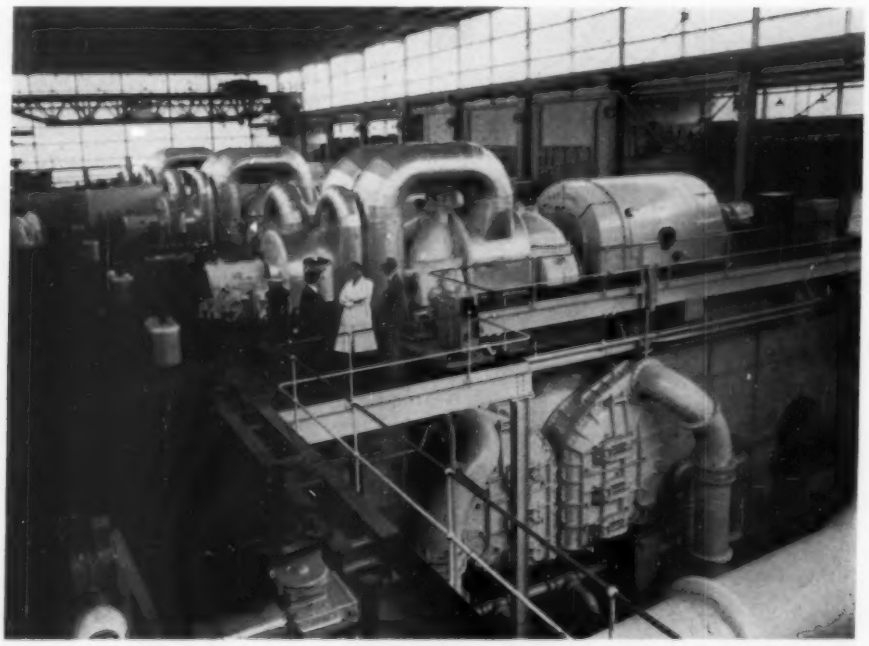


Fig. 5. General view in the turbine hall showing the four 23,000 kw Parsons generators. Heat output from each of the two reactors will produce the steam for these two generators

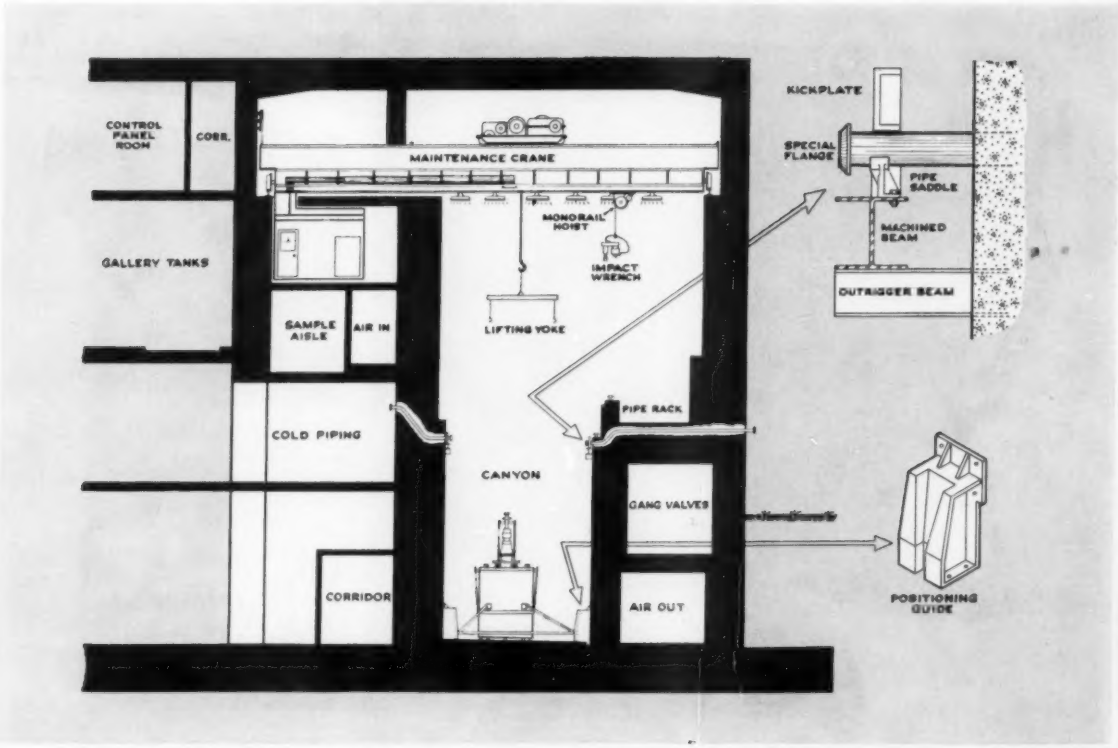


Fig. 1. Cross section of building in which radioactive equipment is maintained. Equipment is located in part called the canyon, and all operations are carried out with the crane. Operator is shielded and uses periscope to see work

Remote-Operated Tools Maintain Radioactive Equipment

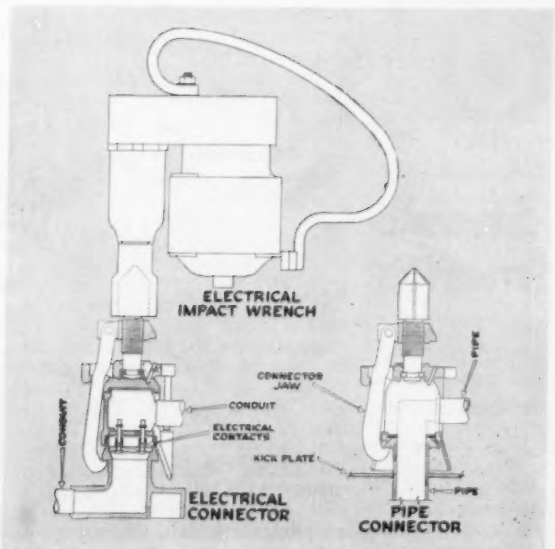


Fig. 2. Special electrical and piping connectors that enable connections to be made or broken without being touched by hand. Connector is operated by an impact wrench which is supported from the crane and worked by the crane operator

REMOTE MAINTENANCE, maintaining equipment without getting too close to it, is likely to become more common in future as the use of radio-active material increases. A foretaste of some of the unusual and difficult problems likely to be encountered was given in a recent ASME paper by Charles G. Strowe, of the Blaw-Know Company, in which he describes some of the ingenious equipment that has been developed for repairing and maintaining equipment that has been used to process radioactive materials. The two illustrations on this page, taken from the paper, give some idea of the equipment it describes.

Equipment in the canyon (see Fig. 1) is designed so that all tasks of installing, maintaining, removing and replacing can be performed by tools used with the crane.

The crane cab is protected from radiation and the operator sees the work by means of two periscopes.

Space microphones are located in the canyon so he can hear sounds to help him operate. In addition, contact microphones are installed on each piece of equipment to help him hear what is going on.

Fig. 1. Left. W. M. Hickam, research scientist, injects sulfur hexafluoride gas into arc. Gas, which is electron-poor, quenches arc by absorbing arc electrons

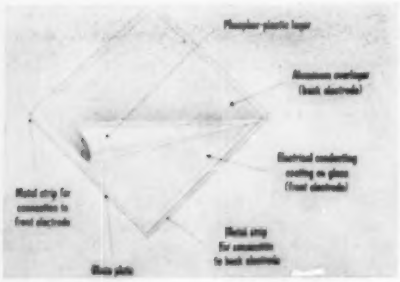


Fig. 2. Above. Rear view of a typical electroluminescent panel, showing its simple sandwich-like construction

New Laboratory Shows Latest Developments

Westinghouse Corporation recently opened their new research laboratories near Pittsburgh, Pa. Here are some of the remarkable developments on which work is proceeding in these new laboratories

ONE OF the developments with great promise for the improvement of electrical switchgear is a new way of quenching an electric arc.

Electron Sponge

Scientists at the research laboratories refer to this phenomenon as an electric sponge, because they use a gas to soak up the arc's electrons much as a sponge soaks up water.

Certain types of gas are electronegative, so called because the gas molecules will attach themselves to electrons, thus becoming negatively charged. Such a gas, introduced into an electric arc, immediately extinguishes it by capturing its electrons.

One gas currently under investigation is sulfur hexafluoride, or SF_6. Figure 1 shows a 10,000-v arc which was immediately extinguished when a small quantity of SF_6 was introduced into the arc.

This development obviously has great potentialities in the manufacture of better circuit breakers.

Electroluminescence

Electroluminescence refers to a new light source obtained by subjecting suitable phosphor powders to an alternating electric field. The action of the field causes the phosphors to glow with a soft, even illumination. The phosphors are embedded in a plastic sheet which is spread on a glass plate coated with a transparent, but electrically-conducting varnish. On the back of the plastic is placed a sheet of aluminum foil. This construction is shown in Fig. 2. Thus the panel resembles a capacitor, with two conducting layers separated by a dielectric. When an alternating current is passed between the glass plate and aluminum foil, the electric field produced causes the phosphors to glow. Several of these panels are shown in Fig. 3.

Though this phenomenon has been known for several years, it is only recently that the efficiency of the

Fig. 3. E. G. F. Arnott, director of lamp division research, demonstrates a variety of electroluminescent panels

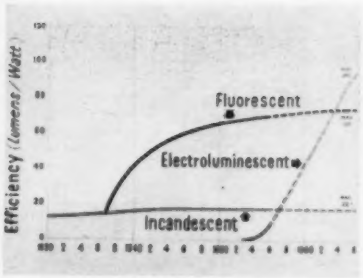


Fig. 4. Chart shows new type of lighting has higher possible efficiency than either fluorescent or incandescent

Fig. 5. Three dimensional model used to show effect of increasing steam pressure above supercritical level

process has been raised enough to give it practical value. The efficiencies at present are still low and the voltages and frequencies required are rather high, yet there is great promise of large gains in efficiency with lowering of the voltage and frequency. Once this occurs, commercial possibilities of the system are enormous.

One of the things that makes electroluminescence so promising as a light source is the high upper limit of efficiency that can be reached. This efficiency limit is four times as high as that of today's fluorescent lamp and more than twice that of the best fluorescent lamp of tomorrow. Figure 4 shows a comparison between incandescent, fluorescent, and electroluminescent lighting.

The panels give off a very pleasing, even, and soft light, an since some phosphors have more than one emission band, frequency can affect the color emitted. One demonstration cell was made to change through blue, green, orange and red by varying the voltage and frequency of the supply. Employed on a large scale this principle would permit changing the lighting of a room to any shade of white by merely turning a knob.

The thinness of the panels means that a room can be entirely covered with illuminating panels. These panels may also form part of the construction of domes, balustrades, and other architectural designs.

Molybdenum Cladding

At the present stage of progress on jet engines and gas turbines, an increase in temperature gives an almost proportional increase in efficiency. One of the limiting factors in gas turbine development has been the ability of alloys to stand these high temperatures.

New alloys developed in the laboratory should permit a substantial step forward in gas turbine design. The qualities of these new alloys were demonstrated by subjecting specimens to stresses at high temperatures. Inconel, a nickel-based high temperature alloy, broke at a temperature between 1350 and 1450 F.

Molybdenum did not break even at 1850 F, but did begin smoking at about 1300 F. This was due to oxidation, which would rapidly burn up the metal if allowed to continue. However, when heat was applied to molybdenum clad with Inconel, the specimen neither burned nor broke even at 1850 to 1950 F.

During the development of this alloy it was found that when Inconel was rolled on molybdenum at high temperature, a layer of hard, brittle material formed between the two alloys which made the cladding alloy tear away easily. The metallurgists discovered that this intermetallic compound could be eliminated by placing a barrier material such as palladium between the two alloys.

It is hoped to get as much as 15 per cent increase in efficiency in gas turbines and other types of heat engines by using this new material.

Solventless Silicones

Up to now, in order to use high-temperature resins for electrical insulation, a solvent has usually been necessary to make the resin adequately fluid for application. The solvent often caused bubbles to form as the insulation hardened into solid form. Now a new insulating material has been developed jointly by Westinghouse and Dow Corning Corp. which is virtually a silicone resin requiring no solvent.

This new insulation, which insures the absence of voids in insulation, will enable electrical equipment to be made more compactly and to be operated at higher voltages and higher temperatures. As an example, a class "A" conventionally insulated transformer weighing nearly 9 lb could, by using the new insulation, be reduced in size to only 4¼ lb; a weight-saving of about 50 per cent.

Supercritical Steam

At the new laboratories, research proceeds on the mechanical properties of materials to be used in the new supercritical steam turbines.

Figure 5 shows a three-dimensional model illustrating the difference between subcritical and supercritical steam. The surface of the model is contoured to show the volume of water at various temperatures and pressures. At atmospheric pressure, water boils at 212 F and expands into a mixture of liquid and gas with an increase in volume of 1600 times.

In a contemporary steam power generating station, water at a subcritical pressure of 2000 psi is heated to about 640 F when it boils into steam. As the pressure moves above the critical pressure of 3206 psi, water when heated expands from a liquid into gas in one continuous phase without boiling, no matter how high the temperature.

Automex

A machine which may have wide application in controlling power and industrial processes is an automatic experimenter developed in the laboratories. It is essentially a computer that is capable of distinguishing between success and failure in a number of experimental steps, and it arrives at its goal by repeated experiment.

For example, consider the case of an operator or a process, say a chemical reaction. It may be that all the operator knows about the process is that he can turn some knobs and that the result on the output registers on a dial. He is paid to keep the needle on the dial at as high a level as possible.

Automex provides such a control. It does not need to know the inner workings of a process to control it. Each step the machine takes is experimental and furnishes the basis on which the next step must be taken. The next step is the one most likely to lead to success. And so on with each successive step.

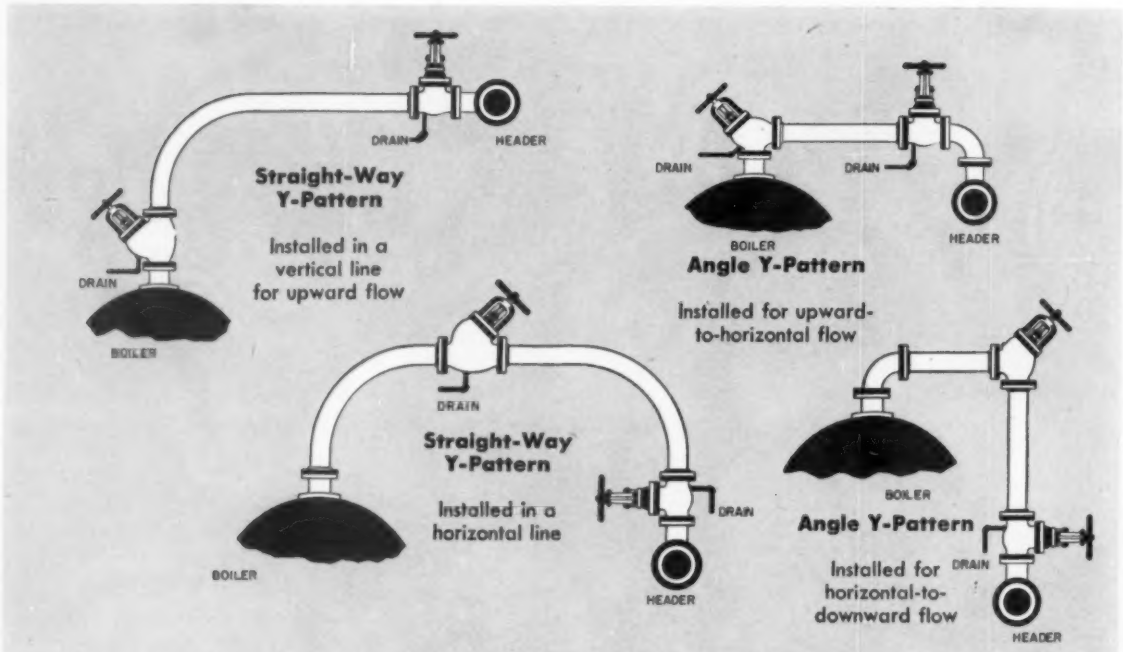


Fig. 1. As shown by this illustration, the Y-pattern angle valve permits wide choice in selecting piping arrangements

Select Right Boiler Stop-Check Valves

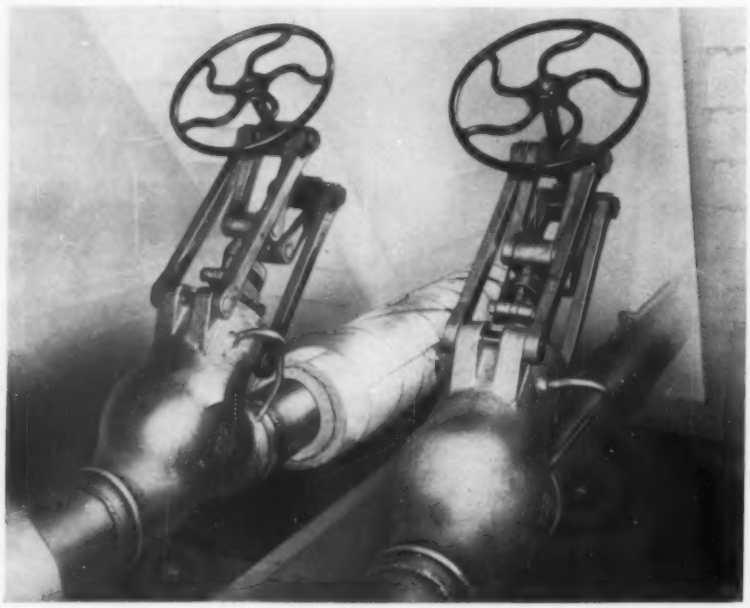


Fig. 2. Two Y-pattern globe stop-check valves with pressure seal bonnets and toggle operating mechanism in central station main steam piping (900 psi, 900 F)

By E. P. DeCRAENE *

WHEN TWO OR MORE boilers are connected to a common steam main, it is required by the ASME Boiler and Pressure Vessel Code, Section I, that the steam connection from each boiler be fitted with two stop valves. The stop valves shall consist, preferably, of one automatic non-return valve (set next to the boiler) and a second valve of the outside-screw-and-yoke type.

Although the automatic non-return valve, commonly referred to as the stop-check valve, is not mandatory under the rules of the code, and an ordinary stop valve could be used instead, it is normally considered essential to safe operation of a boiler plant as are safety valves and other safety devices attached to the boilers. Practically all multiple boiler installations are equipped with automatic non-return valves on each boiler.

The stop-check valve performs three important functions in the boiler steam piping:

1. It automatically prevents a back flow of steam from the main

* Asst. Directing Engineer, Crane Co.

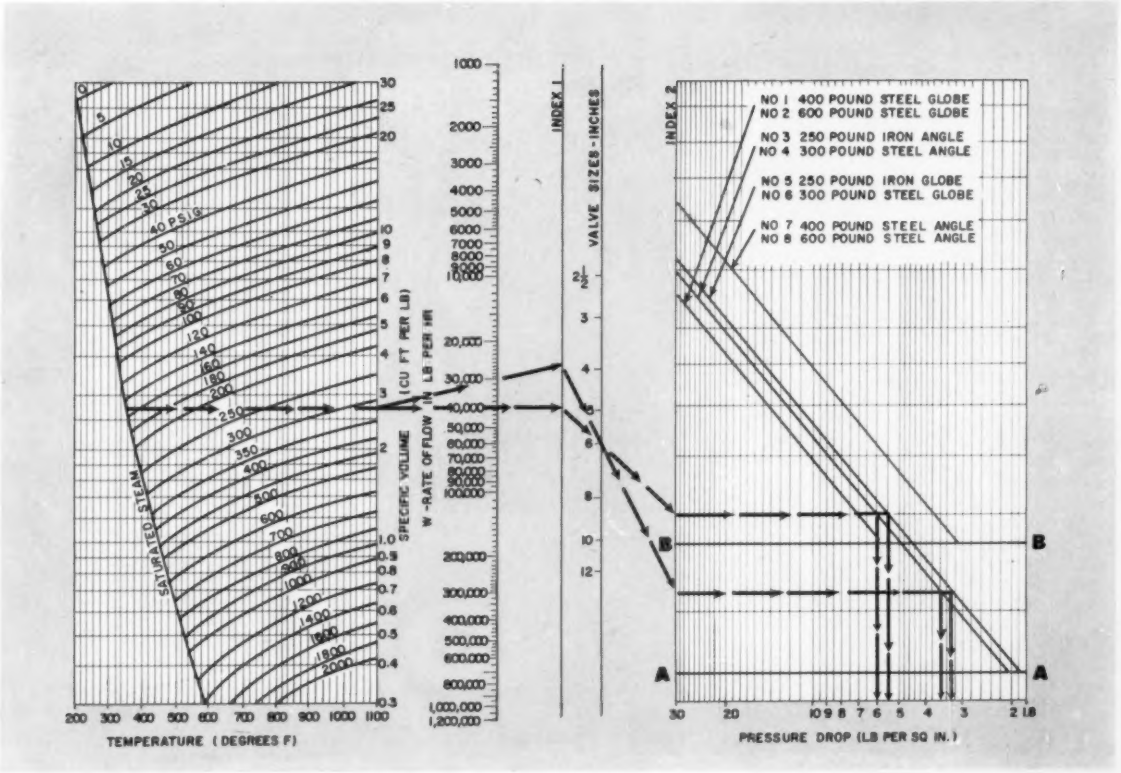

NO 1 400 POUND STEEL GLOBE
NO 2 600 POUND STEEL GLOBE
NO 3 250 POUND IRON ANGLE
NO 4 300 POUND STEEL ANGLE
NO 5 250 POUND IRON GLOBE
NO 6 300 POUND STEEL GLOBE
NO 7 400 POUND STEEL ANGLE
NO 8 600 POUND STEEL ANGLE
INDEX 1
INDEX 2
VALVE SIZES-INCHES
W - RATE OF FLOW IN LB PER HR
SPECIFIC VOLUME (CU FT PER LB)
SATURATED STEAM
TEMPERATURE (DEGREES F)
PRESSURE DROP (LB PER SQ IN.)
A
B

Fig. 3. In nomograph above, example of method used for selecting proper size of stop-check valve is shown by dashed line

steam header to the boiler in the event of a failure in that boiler. It functions in the same manner when ceasing to fire the boiler. The stop-check valve also serves as a "safety-first" valve in preventing flow of steam from the header to a boiler which has been shut down for inspection or repair, should an attendant accidentally open the valve.

2. It assists in bringing the boiler into service after it has been shut down. This operation requires considerable care when performed manually, but the stop-check valve performs this function automatically, without pressure fluctuation or disturbance of the water level.

3. The stop-check valve serves as a globe or angle stop valve to secure or isolate the boiler and permit required periodical hydrostatic inspection tests without complete plant shut-down.

Selection of the best stop-check valve for a given set of service conditions requires consideration of a number of factors, some of which are discussed below:

Materials: For boiler pressures up to 250 psi and temperatures to 450 F, high-strength cast iron bodies and bonnets are successfully used and offer the greatest economy in initial cost. The most satisfactory seating materials for this class of valve is a high grade leaded tin bronze.

For boiler pressures in excess of 250 psi and temperatures in excess of 450 F, cast carbon steel or alloy steel is required for bodies and bonnets. The temperature limitation when welding-end bodies are used is 775 F for carbon steel and 875 F for carbon moly steel, due to the tendency of these materials to graphitize at higher temperatures. Manufacturers' catalogs should be consulted for pressure-temperature ratings of valves.

For the ASA 300-pound class of valves, 12 to 14 per cent chrome stainless steel body seats with stellite faced discs have been found to provide an excellent seating combination. For the ASA 400-pound and higher pressure classes, stellite faced body seat rings and discs with base metal the same as the body material provide the most satisfactory seating combination.

Construction: The Y-pattern globe valve, which is available in 250-pound iron and 300-pound steel classes as well as in 900-pound and higher steel valves, has low pressure drop characteristics. The Y-pattern angle valve, also available in 250-pound iron and 300-pound steel, is unique in that it permits a maximum variation in piping arrangements, as illustrated by Fig. 1.

Construction utilizing the greatest simplicity of design is, of course, desirable. All parts subject to wear or service damage should be readily accessible for easy inspection and servicing. Belted bonnet construction is the most practical and satisfactory for 600-pound and lower classes. Practically all modern installations on boilers using 900-pound or higher classes of valves are equipped with pressure-seal bonnets.

The pressure-seal bonnet has many advantages over the bolted bonnet for high pressure-high temperature joints, including greater ease of assembly and disassembly for inspection and servicing, considerably less bulk and weight, and greater freedom from leakage under adverse service conditions such as sudden temperature changes.

Since stop-check valves must be secured, during a boiler test, against a hydrostatic pressure under the disc equal to 1½ times the boiler pressure, stems and operating devices must be provided that are capable of applying and sustaining relatively high loads against the disc. Hammer blow hand-wheels are commonly used on large sizes or high pressures. Toggle mechanisms, illustrated in Fig. 2, are also very successful in obtaining the high loads required to assure tight seats.

Size and Pressure Drop: Stop-check valves have a floating disc member, the position of which is controlled by the rate of flow through

the valve. The pressure drop due to the valve, expressed in terms of equivalent length of straight pipe or a flow resistance coefficient "K", is not constant until the flow rate is sufficient to sustain the disc in a wide open position.

If the disc floats in a partially open position during a substantial part of the time that the boiler is in operation, rapid wear of the contacting surfaces of the moving disc and possible noisy operation due to fluttering of the disc may result. It is, therefore, important for maximum service life that the valve be sized to provide full disc lift under actual flow conditions.

The practice of sizing the stop-check valve on the basis of the boiler outlet nozzle size should be avoided as this has often resulted in the installation of oversize valves with resultant faulty operation and premature wear. Furthermore, an oversize stop-check valve will not result in a reduction of pressure drop since the partially closed disc creates a restriction at the seat which will cause resistance to flow that is comparable to that caused by a smaller properly sized valve. On the other hand, too small a valve will, of course, create excessive pressure drop.

The minimum flow conditions required to sustain a stop-check valve in a wide open position, as well as the pressure drop due to the valve, will vary widely with the various types and designs of valves available. This information must be developed by the valve manufacturer on the basis of laboratory and field tests. Pressure drop data and flow characteristics of valves are published in the catalogs or supplementary literature available to users by those manufacturers who recognize the importance of properly sizing stop-check valves.

The chart in Fig. 3 presents this data for eight lines of stop-check valves in a form that permits an accurate and direct method of determining the best size of stop-check valve, as well as the pressure drop under varying conditions of flow, without any computations.

The chart is a graphical solution of the general flow formula and incorporates the flow characteristics which have been determined by tests for the eight lines of valves in the graph at the right hand side of the chart. Lines could be added to this or a similar chart to include any line of valves for which flow test data is available.

Selection Example: The following example is presented to illustrate the use of this chart:

Given:

Two boilers connected to a common header.
Steam conditions: 150 psi saturated
Flow rate: Normal 30,000 lbs/hr each boiler
Maximum 40,000 lbs/hr " "
Minimum 10,000 lbs/hr " "

Find: Class of valve, best size and pressure drop at normal and maximum flow rates.

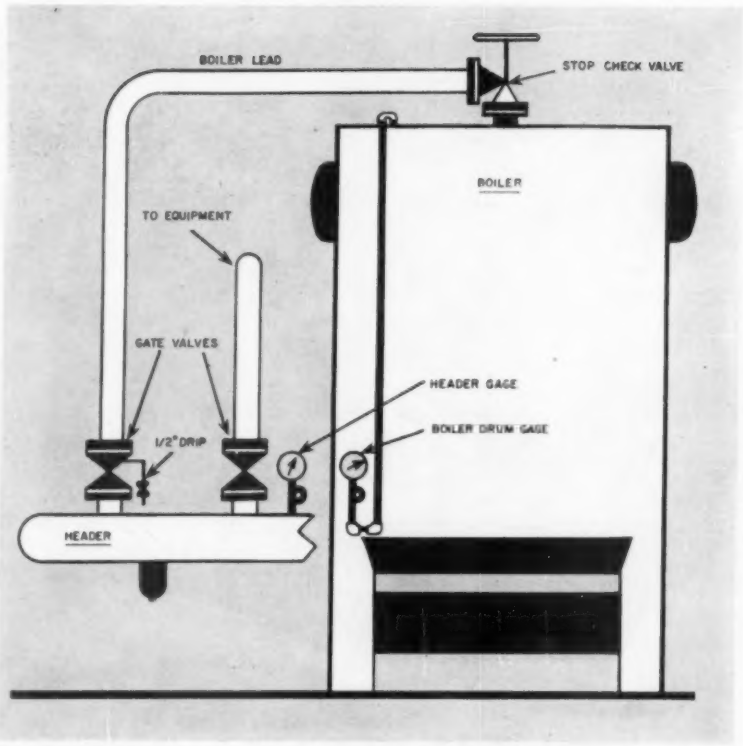


Fig. 4. Diagram shows how installation of header and boiler drum gage on same level may lead to incorrect estimation of pressure drop in stop-check valves

Solution: Reference to valve manufacturer's catalog ratings will show that an iron valve of the 250-pound class is suitable for this service. Choice of a globe or angle type will depend upon desired piping arrangement, space limitations, etc. Valves designated as No. 3 and No. 5 on the graph represent the angle and globe valves, respectively.

Enter the chart at 150-psi saturated steam as indicated, and move horizontally to the right where the specific volume may be read as 2.75 cu ft per lb. From this point, draw a diagonal line through the flow rate being investigated and establish a point on the line marked "Index 1". Draw another diagonal line from the point on "Index 1" through any valve size that will cause the line to to terminate on "Index 2" anywhere above point "A." From the point on "Index 2," proceed horizontally to the intersection with the line representing the selected class of valve, then vertically downward to read the pressure drop on the base line of the chart. Pressure drop data as read from the chart is given in the following table:

Flow rate lb/hr	No. 3 angle valve	No. 5 globe valve
30,000	3.75 psi	3.4 psi
40,000	6.1 "	5.6 "

Chart solutions resulting in a point on Index 2 that fall below point "A" for No. 3 and No. 5 stop-check valves indicate that the valve disc will not be fully lifted under the flow conditions used. Under such conditions, the pressure drop through the valve will be 1.9 psi or less for the No. 5 and 2.1 psi or less for the No. 3 valve.

Operation under such conditions is not recommended but, at times, must be tolerated for short periods during the low load portion of the operating cycle. The 10,000-pound flow rate in this example represents such a condition. Experience has shown that the disc is normally stable at an intermediate position under such conditions, providing there is no rapid or excessive fluctuation in the steam flow rate.

If the pressure drop in the piping system is excessive, then the cost of steam delivery will be too high. It can become prohibitive, causing the redesign of the entire system. One of the valves usually blamed for excessive pressure drop is, of course, the stop-check valve. Here is a point at which engineers can woefully deceive themselves, blaming the valve for things unrelated to its functioning.

A particular case where a stop-check was blamed for an engineer's mistake is one in which the engineer innocently extended the boiler-drum gage line down from the drum to eye level, Fig. 4. Close by was the gage on the steam header. The boiler drum gage showed a pressure of 150 psi while the header gage showed 130

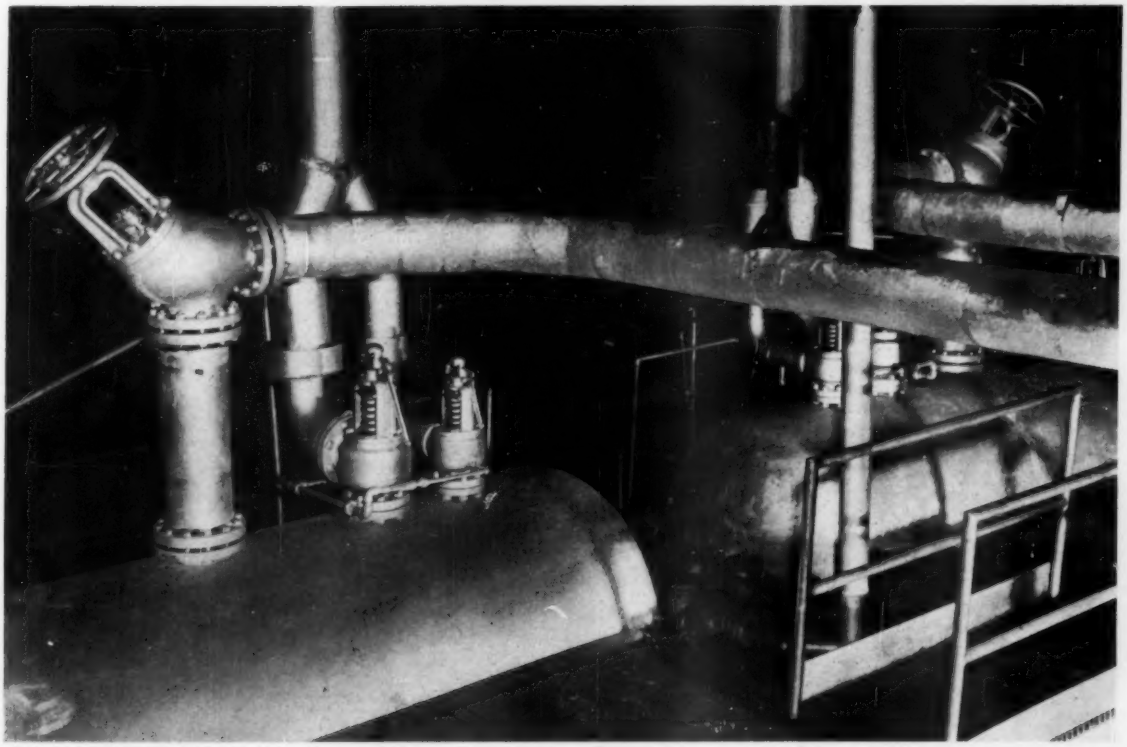


Fig. 5. Illustrated here is a standard installation of typical Y-pattern stop-check valves on two low-pressure boilers used in a New York state canning plant

psi, giving the impression that the stop-check and boiler lead were developing a drop of 20 psi.

A check of the gages proved them to be correctly adjusted. What had been overlooked, however, was the 40 ft of gage line which had filled with condensate. Since a foot of water exerts a pressure of 0.43 psi, it is easy to see that the boiler drum gage was giving a false reading due to weight of the column of water.

A simple method of correcting this condition is to reset the indicating needle on the gage to zero when it is known that the gage line is full of condensate and there is no pressure on the boiler.

Trouble from Dirt: Dirt and scale can be the cause of much trouble in stop-check valves. In a new installation the boilers are carefully washed out, every effort being made to get all of the loose scale out of the tubes and drums. When the boiler is put under pressure and heated to its working temperature, scale that was not dislodged by the washing may come loose. As the velocity of the steam leaving the boiler increases, it will pick up this scale and dirt from the superheater forcing it directly into the working parts of the stop-check valve. After the first test run, the stop-check valves should be opened and thoroughly cleaned. This will save a lot of trouble and may save overhauling the valve later.

Valves that have been in service for a long time, especially where feed water treatment is carried on in the boiler itself, frequently become coated with scale that becomes very hard. This may cause the disc to become stuck in a partly open position, producing an excessive pressure drop and completely eliminating the safety feature that the stop-check valve is supposed to provide. Neglect in inspecting and cleaning these valves can lead to serious accidents as well as exacting a perpetual toll of unnecessarily high operating cost.

Any safety device is dangerous unless it is regularly inspected and tested. A stop-check valve, even though properly sized and perfectly manufactured, can only deliver perfect service if it is properly cared for.

Stuffing-Box Maintenance: Proper stuffing-box maintenance is simply a a matter of good housekeeping, and applies not only to stop-check valves but to every valve in the plant. Valve glands should be adjusted as soon as any leakage is detected. Gland flanges must be pulled up evenly to avoid contact with and possible damage to the stem.

When it becomes necessary to add packing or to repack valves, care should be exercised to avoid damaging the valve stem. The use of proper tools for removing old packing and replacing with new packing will aid greatly in this respect. Each ring should be individually pressed into place. The use of a split sleeve fitted around the stem under the gland is very useful for properly inserting the rings in the bottom of the box. The diagonal cuts of split packing rings should be staggered about 120 degrees between adjacent rings.

Use of chisels, files, or drift punches for tamping rings into place should be avoided because stems can be easily dented with such tools.

Second Stop Valve

The second main steam stop valve required by Section I of the ASME Boiler and Pressure Vessel Code is usually, and preferably, a gate valve, for the following reasons:

1. The pressure drop through a gate valve is very low.

2. The valve at this location is invariably either in the wide open or closed position. (Gate valves are not recommended for throttling service.) Operation of this valve is normally infrequent. Under these operating conditions there is little, if any, tendency for the seats to wear or become damaged, and need for servicing is, therefore, unlikely. However, should the need arise, repairs can readily be made by competent mechanics.

3. The power required to operate gate valves is low. The stem force required to obtain tight seats is only about one-third of that required with globe or angle valves for the same service conditions.

(*Above*) Loading a critical assembly. Note that the halves of the reactor are moved apart to ensure subcriticality during loading. (*Right*) Control room for a critical assembly. TV receiver is used to view reactor while it is in operation

Misconceptions about nuclear engineering work are partly responsible for the present shortage of engineers in the atomic field. Description given here of the composition and work of a typical nuclear engineering group helps to clarify the role of the nuclear engineer in modern industry

Engineers and Physicists for Nuclear Engineering

By P. L. HOFMANN*

COMPANIES WORKING in the nuclear reactor field are often unsuccessful in attracting an adequate number of professional persons to work in their nuclear engineering groups. Part of this failure can undoubtedly be attributed to the general shortage of engineers and scientists. On closer examination, however, it does seem that more specific reasons than just the general shortage might be responsible for this situation.

Persons who would qualify as professional workers in nuclear engineering can be drawn either from conventional engineering fields or from the fields of physics and applied mathematics. The demands which are put on a nuclear engineering group are so varied and have so many technical implications that for the group to be effective it must incorporate a great variety of special talents, interests and skills. It would therefore seem that nuclear engineering should have a broad appeal to a wide circle of professional people.

Apparently, however, industry has not done an effective job in selling this idea to the potential nuclear engineers. Very often one finds that nuclear engineering job candidates have peculiar misconceptions about nuclear engineering work. If the applicant's training has been along conventional engineering lines, he very often thinks of nuclear engineer-

* Manager, SIR Nuclear Engineering, General Electric Company.

ing as a special branch of theoretical physics which is too abstruse and impractical for the practicing engineer. On the other hand, candidates with backgrounds in physics and mathematics tend to avoid nuclear engineering because of the implication that nuclear engineering is predominantly an applied engineering discipline. Needless to say, both concepts are wrong.

It is hoped that the role of the nuclear engineer can be clarified by a brief description of the tasks and the staff requirements of a typical nuclear engineering group functioning within a comparatively large engineering organization which designs, fabricates and tests power producing nuclear reactors. This organization would most probably include a technical engineering department consisting of several sections; e.g. reactor physics, reactor design, reactor system design, reactor fabrication and reactor operations. The nuclear engineering group, which will be discussed, might logically be one of the components of the physics section. Another component might be an experimental physics group.

The primary function of the nuclear engineering group is to supply physics information to the design, fabrication and operation sections. In addition, it identifies the significant physics problems arising in other sections and sees to it that these problems are channeled into the appropriate physics groups for solution. It is, therefore, very important for the nuclear engineer to have a very broad reactor physics background as well as a good appreciation for engineering problems. He will then not only recognize the technical problems quickly, but will also be able to indicate the most profitable approach to their solution, obtain the solution and supply the needed information in a useable form to the appropriate engineering group.

Tasks of the nuclear engineering group change somewhat as the reactor design, fabrication and test phases evolve. The classification of these tasks into five broad project areas might be as follows:

1. Participation in the Planning of New Reactor Concepts
2. Participation in the Development of the Reactor Design
3. Evaluation of Reactor Design
4. Contributions to Reactor Fabrication
5. Contributions to Reactor Testing

Each of these project areas will now be discussed in some detail.

1. Participation in the Planning of New Reactor Concepts: One of the most important tasks of the nuclear engineering group is to contribute to the initial planning of new reactor concepts. Assuming that a specific reactor objective (e.g., stationary power plant, mobile power package reactor, naval propulsion plant, etc.) has been defined, the broad selection process can begin. This process is one of continuous compromise among many important factors affecting the reactor design. The criteria for selection a specific reactor are quite numerous and are dependent of course on the specific objective under consideration. Basic to the selection of all reactor plants, however, are three broad criteria:

a. low cost
b. high reliability
c. early delivery date

Relative importance of these criteria depends on the reactor objective. In the case of a power plant for the propulsion of a military vessel, criteria *b* and *c* might be paramount, though obviously criterion *a* cannot be ignored. Incidentally, criterion *a* should be considered in a very broad sense including such areas as fuel economy (i.e., low fissionable material inventories, high burn-up), reactor size (dictated to some extent by space limitations), heat removal schemes (and their ultimate effect on plant size and efficiency), and many other areas.

Criterion *b*, high reliability, also encompasses plant safety. The importance of this criterion is self-evident. Also obvious, particularly in the case of military equipment is criterion *c*, early delivery date.

The general area of reactor planning requires an over all awareness of what is going on in the reactor field within, as well as outside, the United States, in order to determine the most promising future reactor concepts from a market point of view and to evolve new, creative reactor ideas.

2. Participation in the Development of the Reactor Design: Once a basic conceptual reactor design for a specific reactor application has been adopted, certain initial investigations must be perused to answer fundamental questions.

a. Determination of Critical Mass and Size: One of the fundamental questions concerns the establishment of the optimal critical mass. This optimal critical mass should not be confused with the mass required for the initial reactor fuel load. The term critical mass as used here refers to the "intrinsic mass" necessary to maintain a chain reaction when the reactor composition and configuration is most favorable to the maintenance of this reaction. To arrive at the optimal mass, it is usual to survey a large number of possible reactor configurations and materials.

In addition to nuclear parameters, a large variety of engineering design parameters particularly those arising in the area of heat transfer must be evaluated. The materials to be considered in such a survey must be suitable for reactor application and available in the necessary quantities at reasonable prices. The reactor configuration, size and composition must be compatible with the demands placed on it by its basic power generating function. The eventual size of the reactor core, reflector and necessary shield must be compatible with the space limitations imposed by the over-all reactor specifications. This latter limitation is obviously extremely important for reactors for mobile application.

b. Determination of Reactor Endurance: The objective of all power reactors is to sustain operation for a long time at appreciable power levels, usually in the megawatt range. To achieve this endurance, it is necessary to supplement the intrinsic mass of the reactor so that provision is made for the loss of fissionable materials by fission and other processes (e.g. radiative capture of neutrons) as well as the loss in reactivity resulting from the accumulation of fission product poisons. Hence the initial fuel (fissionable material) load of the reactor, in general, includes the intrinsic mass, fuel for burnup, and fuel to compensate for fission product poisoning.

In long-endurance, high-power reactors, the initial load is often many times larger than the intrinsic mass. The nuclear engineering group must supply answers regarding the question of initial reactor loads. It is also called upon to answer questions regarding the manner in which this fuel load is to be controlled during reactor operation. For example, if reactor shim (long range) control is accomplished by means of core poison control rods, the nuclear engineering group must indicate the number, location and nature of such rods to obtain maximum control effectiveness.

c. Determination of Kinetic Characteristics: When basic size, composition and fissionable material inventories have been determined, the next step is to analyze the kinetic behavior of the reactor. The area of electronic circuitry and reactor instrumentation generally associated with this field will not be included in the nuclear engineering responsibilities. In a large organization this problem is usually handled by components of a section dealing with the reactor system design. However, certain design features of the reactor core may have characteristics which will profoundly affect the kinetic behavior of the reactor. It is the responsibility of the nuclear engineering group to isolate these features and to evaluate their effects. Probably the most important problem in this respect is the analysis and evaluation of reactor temperature coefficient, i.e., the response of the reactor to temperature changes.

These coefficients stem from a variety of causes such as expansion of reactor structure and coolant, neutron temperature shift, Doppler broadening of fuel and fission product resonances, etc. Because of their importance, it is essential that basic temperature response characteristics of a proposed reactor be at least qualitatively established as

early as possible in the reactor development stage. Temperature coefficients do not only affect the stability of normal reactor operation but they play an important role in the safeguards analysis of the entire reactor system.

d. Development of Reactor Physics Methods: Reactor physics is still a comparatively new branch of physics and the reliability of reactor physics calculations is often uncertain. The field is rapidly developing, however, and it is essential that an active nuclear engineering group keep itself well informed of new concepts, new techniques, such as the use of fast digital computers for the solution of criticality equations, and new and better physics data (for instance, the latest neutron cross sections).

Since many of the available analytical techniques are in such a rudimentary stage of development it is also essential that analytical results be constantly checked and compared with available experimental information. This indicates the importance of coöperation and coördination between the nuclear engineering and other reactor physics groups. If nuclear engineering results are not frequently checked with experimental data the quality of the nuclear engineering work is bound to become "Alice in Wonderlandish."

3. Evaluation of Reactor Design: Following the reactor development stage, in many instances concurrent with it, the actual design of the reactor and of the reactor system proceeds. In this design stage, the nuclear engineering group still has a very important function. Basic reactor concepts established in the preceding development stage must often be modified when specific engineering needs suddenly develop. These changes often affect the reactor physics area and it becomes necessary to re-evaluate many of the original design concepts established in the previous stage.

During the design stage it is also possible to get a firmer grasp of the predicted nuclear characteristics by applying more refined analytical tools to the analysis of the now specific reactor proposal. In the development stage, the survey of a great many reactor configurations is necessary so that the use of refined methods, involving greater costs, cannot be justified. However, once a reference design is established, the use of more powerful analytical tools (for instance, the use of multi-dimensional multigroup techniques) becomes attractive.

At this stage the information required by the conventional engineering groups usually also becomes more specific. As an example of this type of information it might be necessary for the reactor design engineers to know the detailed spatial distributions of heat sources in order to avoid excessive local temperatures in the reactor core. As another example, shield design engineers might require information on the activation of certain reactor components, e.g. the reactor coolant. Such specific information can only be obtained by the use of advanced analytical investigations for very specific reactors. Hence a fairly well progressed design is assumed to exist at this stage.

4. Contributions to Reactor Fabrication: In this area the responsibilities of the nuclear engineering group are slight, although important. The materials used in the fabrication of the reactor must conform to certain nuclear specifications which will insure that no excessive neutron poisons are built into the reactor assembly. It is also necessary to insure that all fabrication processes are conducted in the proper manner so that stray neutron poisons entering the reactor are minimized. The writing of pertinent specifications and procedures represents the greatest challenge in this area. These specifications must be comparatively rigid without imposing undue costs on the process. A suitable balance must be attained between statistical reliability and cost. This is frequently difficult, however, since precise cost information is rarely available.

Another project area arising at this stage is the establishment of proper criticality safeguards precautions in the fabrication of fuel elements. The nuclear engineering group is usually charged with the responsibility of making certain that no criticality hazards arise in the handling, shipment and storage of fuel elements.

5. Contributions to Reactor Testing: The finished reactor or a prototype may be tested before delivery to the customer. These tests cover practically all phases of reactor design and are conducted by a reactor operations section.

The nuclear engineering group, however, has very definite responsibilities in this area too. In particular the group must:

a. Specify the nuclear tests necessary to demonstrate that the plant meets all nuclear specifications.

b. Participate in the nuclear testing of the reactor in order to assure that all necessary data are obtained.

c. Evaluate the test results to show to what extent specifications have been met.

d. Utilize the reactor plant facilities to obtain any other useful information for the design of future reactors.

Personnel Requirements: Thus far we have briefly outlined the tasks of a nuclear engineering group in a large reactor engineering organization. The personnel requirements of such a group will now be discussed.

An effective nuclear engineering group will consist of various professional employees and a sufficient number of engineering assistants. The professional employees might be subdivided into the following categories:

A Physicist-Mathematician: This member of the group should spend practically full time on the development of new calculational techniques; continuous re-evaluation of accepted techniques in the light of new experimental evidence; simplification of standard techniques and survey of new techniques developed elsewhere. He should preferably be a theoretical physicist with a Ph.D. degree and strong interest in applied mathematics.

Reactor Physicists: The reactor physicists should be primarily concerned with the planning of new reactor concepts. They should not only have a good grasp of reactor physics fundamentals, but they should also be well informed on activities at other laboratories and above all they should have creative, original minds which allow them to propose novel reactor schemes. Yet they should have sufficient breadth so that their proposed schemes will not lack realism.

Nuclear Engineers: These engineers make up the remainder of the group. Their training should be through the baccalaureate or master's level. It would also be worthwhile to have one or perhaps even two Ph.D. engineers or physicists in this group. Further, some formal reactor physics background such as that given in the one-year course at the Oak Ridge School of Reactor Technology would be very desirable. At least one member of the group should be well versed in electronics and instrumentation so that he could act as project leader during the reactor testing phase.

In general, all should be sufficiently versatile to participate in the development, design, fabrication and reactor test stages. This variety will not only make their jobs more interesting but will also assure a more competent staff, since information acquired during the development, design and fabrication stages of a particular reactor is of considerable value during the reactor testing stages that follow.

We have attempted to present a brief description of the tasks of a nuclear engineering group and the type of personnel that make up such a group. Experience has shown that nuclear engineering encompasses a very broad field which should have appeal for a great variety of professional people. Nuclear engineering is probably most suitable to physicists who are interested in applied, analytical research and to engineers who enjoy work in the fundamental sciences. In either case it represents one of the best possible areas in which to gain a broad, comprehensive acquaintance with the nuclear reactor field.

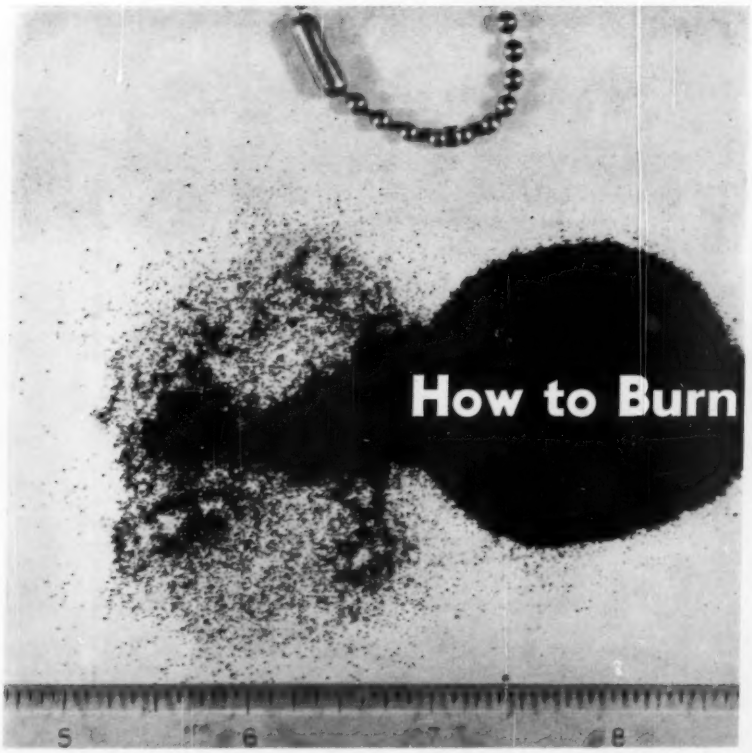


Fig. 1. Natural particle size of fluid coke shown in this photograph with key ring in background for comparison

How to Burn Fluid Coke

Once fluid coke is burning it is an excellent boiler fuel. But getting it started and keeping it burning can be difficult. Here's a summary of the properties and behavior of this new kind of fuel

ENORMOUS INCREASE in the number of automobiles in recent years, with a corresponding increase in the market for gasoline, has made the demand for light distillates grow faster than the demand for heavy fuel oils. Thus there has been a strong incentive to develop processes for converting heavy into light distillates. One such process is the fluid coking process, which gives an increase of something like 20 per cent increase of motor fuel from a given quantity of base fuel. and in addition produces large quantities of residue in the form of fine particles of practically pure carbon, known as fluid coke.

Properties of Fluid Coke: Some confusion is caused by the use of the word "fluid." This does not mean liquid, but merely that the coke is in such a form that it can flow, as shown in Fig. 1, or be pumped into vessels and through pipelines. Actually it looks much like black sand (see Fig. 2), being composed of dry, hard, granular solid particles. These particles are composed of approximately 90 per cent carbon, with the other constituents varying considerably depending on the source of the crude. The following screen analysis of one sample gives an idea of the size distribution.

Per cent retained on 48 mesh..18, 65 mesh..68, 100 mesh..89, 150 mesh ..96, 200 mesh..98.

The ash content is very low, usually less than 0.5 per cent. Grinding and burning properties will be described later.

Fluid coke particles are small and free flowing, so that in open storage the pile may have to be protected to prevent losses from the action of wind and rain. Where possible, a tarpaulin or similar covering should be used, or, as an alternative, oil or tar can be sprayed over the surface of the pile. Similar techniques have been used successfully for storage of coal fines.

How Fluid Coke is Produced: Figure 3 shows the essentials of the process, which uses two large vessels, the reactor, A, and a burner, B. Seed coke, i.e. coke in the form of small seed-like particles, is heated in the burner and passed into the reactor, where it meets the raw preheated fuel, usually in the form of pitch. When the pitch meets the hot seed coke, the lighter fractions are flashed off, while additional coke is formed both as seed coke and in onion-like uniform layers of carbon around the seed coke which builds up to form the product we call fluid coke.

Part of the product coke is ground to produce new seed coke for continuing the process, and part is burned in the burner to provide the heat for process. The process was invented by Esso Research and Eng. Co. which licenses it to industry.

Combustion of fluid coke: Fluid coke has a very low percentage of volatiles, with the result that burning is difficult. To ignite fluid coke, the temperature of the coke particles has to be brought up to and maintained at the ignition temperature. For this reason it is usual to burn fluid coke in combination with a conventional fuel.

Because the coke contains only 0.1 to 0.3 per cent ash, all solids leaving the furnace are likely to contain a high percentage of carbon. Reburning this fly ash results in an appreciable decrease in carbon loss without exceeding the dust loading required by normal city smoke regulations.

Grindability: With standard type rotating ball mills or vibrating ball mills it is more difficult to grind fluid coke than coal owing to the spherical shape of the fluid coke particles. Generally speaking, the capacity of a given mill for coke is 45–50 per cent of that of an average bituminous coal of about 55 Hardgrove grindability index. Power requirements are in proportion, so that grinding cost may be taken as 2 to 2½ times as much as for a conventional boiler-furnace bituminous coal. With a ball mill, if conventional coal grinding costs are taken as 25¢ per ton, the costs for grinding fluid coke would be of the order of 60¢ per ton.

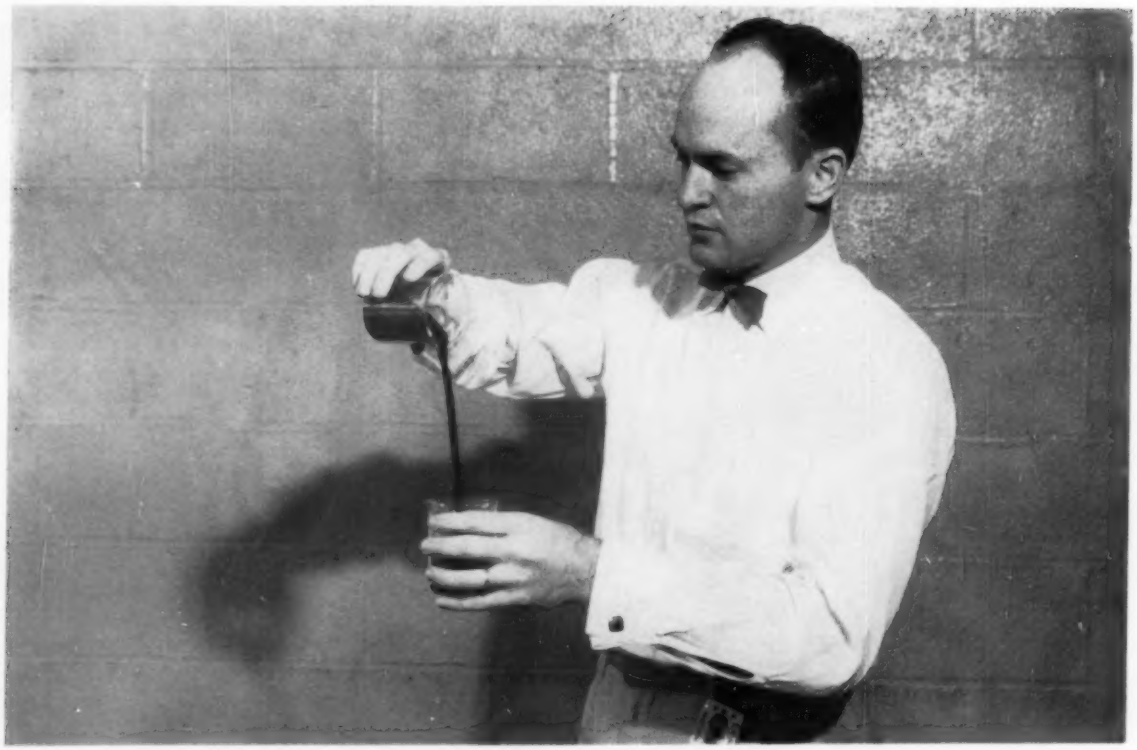


Fig. 2. Fluid coke consists of dry, hard, granular solid particles, composed of approximately 90 per cent carbon. As this photograph shows, it can be poured easily and it can also flow or be pumped into vessels and through pipelines

Burning Difficulties: Fluid coke is quite different from the petroleum cokes that have been obtained in the past. Fluid coke is very dense, exposes a minimum of surface for oxidation, is very hard to ignite, is hard to maintain in stable combustion, and contains only from 4 to 5 per cent volatile matter. It is necessary to burn some auxiliary fuel with it to maintain ignition temperature.

In order to ignite fluid coke it is necessary to maintain the temperature of the coke particle at ignition temperature. This can be accelerated by using the highest possible primary air and coke temperature and using burner nozzles which are as small as possible.

Temperature of the coke has to be raised to the 1400 F ignition temperature before burning can take place. The higher the initial temperature of the coke and air mixture, the quicker ignition will take place. Temperatures up to 400F for primary air and coke stream have been used and even higher temperatures are being considered in new designs. By using a pulverizer with bearings external to the main body of the pulverizer and with an adequate cooling oil circulation, operation is quite satisfactory.

By using a number of small nozzles,

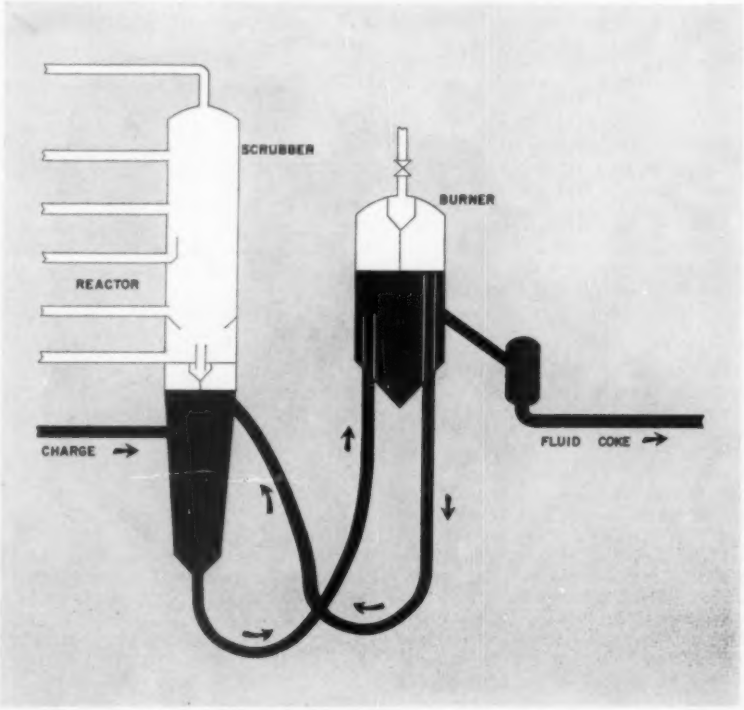


Fig. 3. Diagram of fluid-coke process used to increase yield of motor fuel from base fuel. Fluid coke, suitable for boiler fuel, is a by-product of the process

the surface of the fuel exposed to radiant heat from the flame is much greater than when a single large discharge nozzle is used and so ignition is maintained more easily. Figure 4 shows a burner arrangement that has proven successful in practice.

One of the difficulties in burning fluid coke is that due to the low proportion of volatiles in the fuel there is not enough volatile matter to form a flame of any magnitude. Time required for the carbon particles to reach ignition temperature is such that the flame cannot be held at the burner throat and unstable ignition or flame failure results unless a considerable quantity of auxiliary high volatile fuel is used.

A rough comparison of ignition times shows that, with similar burning arrangements, if the ignition time of bituminous coal varies from 25 to 32 milliseconds, the ignition time of fluid coke would be about 37 to 41 milliseconds. In the furnace shown in Fig. 5, which is of suitable type for burning fluid coke, the coke air stream ignited about 12 in. from the burner nozzle. By the time the coke particles reached the center of the furnace their velocity was reduced to zero and the particles had acquired a vertical velocity as shown on the diagram. However, the particles were then burning at a temperature of approximately 3000F and obviously with a flame front of this magnitude and temperature the burning of the coke particles would continue even if the vertical velocity were increased to about 10,000 ft per min. In the furnace shown, the vertical velocity at the point of least cross-section is less than 2500 ft per min, so that very stable furnace conditions can be expected.

Reinjection: Fluid coke contains only from 0.1 to 0.3 per cent ash, so all solids leaving the furnace are likely to contain a high percentage of carbon. Burning this fly ash results in an appreciable decrease in carbon loss without exceeding the dust loading required by smoke regulations.

Ash: In firing fluid coke, the unburned carbon represents the major part of the solids withdrawn from the furnace. With coals, however, approximately 10 per cent additional ash also goes out of the system, so for comparable total solids lost in combustion, fluid coke could afford to have up to say 10 per cent unburned carbon. Since the heating value of fluid coke will be of the order of 14,000 Btu per lb, the net heat available even with higher unburned carbon compares favorably with run-of-the-mine coal, such as is normally fed to large-scale boiler furnace installations, and, as explained above, much of the loss can be recovered by reinjection.

For the information contained in this article we are indebted to Esso Standard Oil Company and Riley Stoker Corporation.

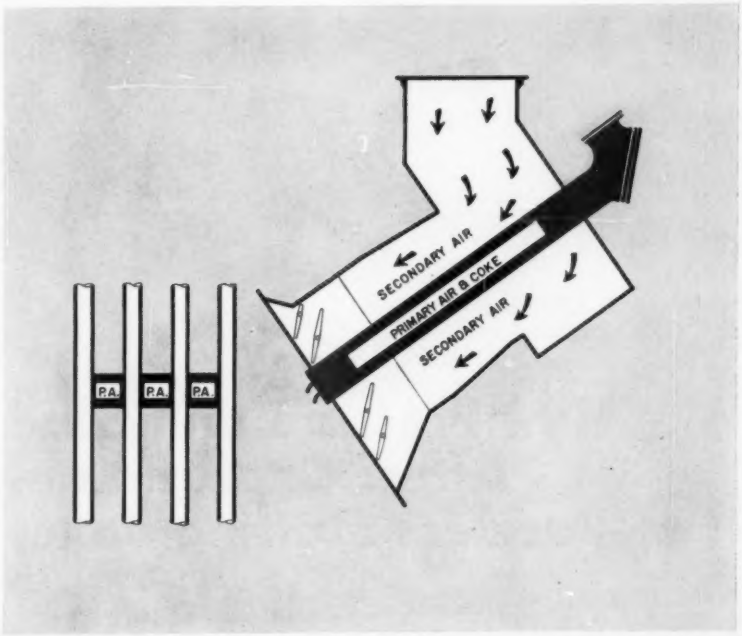


Fig. 4. Burner arrangement for burning fluid coke. The object of this design is to expose as much of the fuel surface as possible to radiant heat from the flame

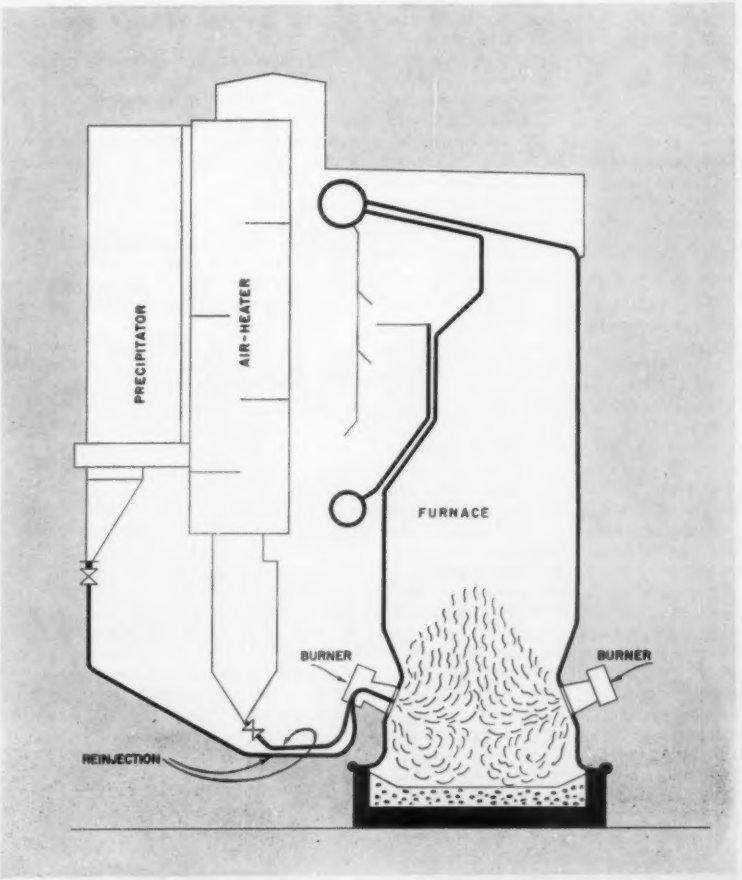


Fig. 5. One type of furnace for burning fluid coke. Owing to longer ignition time than for ordinary fuels, fluid coke ignites about 12 in. from the nozzles

How Pressure and Load Affect Operation of Packless Stuffing Boxes

By IGOR J. KARASSIK*

IN SEPTEMBER we described the construction of the packless stuffing box for high speed boiler feed pumps. We must now examine the relationship between the pressure available at the injection of the condensate and the internal pressure over the complete range of operating station loads. For reasons which will become obvious in our examination, this relationship is vastly different for open and for closed feedwater cycles, and we shall study the application of packless boxes for the two cycles separately.

Open Cycle

The relationship of the various pressures under consideration is illustrated in Fig. 1, which represents a typical installation with injection type labyrinths in an open cycle. The condensate pump discharges into a deaerating heater through a series of closed heaters. The discharge pressure at the condensate pump rises from 170 psig at full load to 215 psig at 1/4 load. The static head between the condensate pump and the deaerating heater is 80 ft, or approximately 35 psi. The friction losses in the piping and through the closed heaters are 45 psi at full load and only 3 psi at 1/4 load. Thus, the pressure immediately ahead of the heater will be 90 psig at full load and 177 psig at 1/4 load. A condensate control valve is located at the entrance to the deaerating heater which will vary the admission of condensate in accordance with load requirements. It will throttle off approximately 20 psi pressure at full load and as much as 170 psi at 1/4 load.

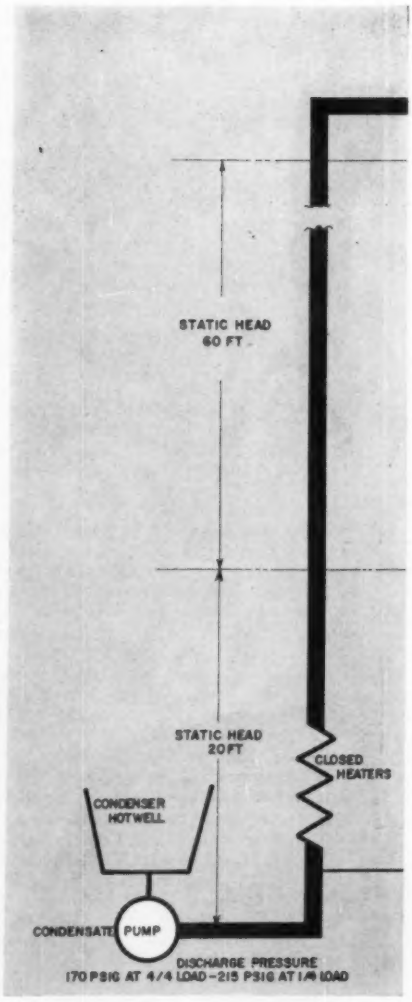
The boiler feed pump centerline is located at 60 feet below the water level in the deaerating heater. The friction losses in the suction piping are 3 psi at full load and 0.2 psi at 1/4 load. Thus, the suction pressure at the boiler feed pump varies from 90.6 psig at 4/4 load down to 31.4 psig at 1/4 load. This is also the internal pressure on the suction side of the pump.

On the discharge side, the internal pressure will be somewhat higher. In an open feedwater cycle, the balancing device leak-off is returned to the deaerating heater. The calibrated orifice in this return line can be assumed to have a loss of 5 psi and the return piping itself another 5 psi friction loss. Thus, the internal pressure on the discharge side will exceed that on the suction side by approximately 10 psi, and will therefore range from 100.6 psig at 4/4 load to 41.4 psig at 1/4 load.

What of the injection pressure? Since the condensate pump is located 20 feet below the boiler feed pump and if we assume friction losses of approximately 6 psi in the injection line, the injection pressure will range from 155 psig at 4/4 load to 200 psig at 1/4 load. Thus, the injection pressure will amply exceed the internal pressures at all loads and if we wish to minimize both the amount of inward flow and of the condensate being returned to the condenser and being repumped, we will do well to provide the injection lines with control throttling valves. If we wish to maintain, let us say, 5 psi differential between the injection pressure and the internal pressure, the amounts of pressure to be throttled will be:

1) At the suction side,
   64.4 psi at 4/4 load and
   168.6 psi at 1/4 load
2) At the discharge side,
   54.4 psi at 4/4 load and
   158.6 psi at 1/4 load

There should be no difficulty in selecting control valves which will maintain the desired pressure differential and the rather high value of the pressure to be throttled will permit us to select a reasonably small size valve for the purpose.



Closed Cycle

It remains to examine the problems which may arise in the application of the packless stuffing box in a closed feedwater cycle. Figure 2 represents conditions prevailing at the discharge (balancing device) side stuffing box, where we shall presently see the conditions are actually more severe than at the suction side.

At full load and down to some reduced load conditions, the injection pressure (P_B) is greater than the pressure in the balancing device relief chamber (P_A) by virtue of the friction losses between the discharge of the condensate pump and the suction of the boiler feed pump. Inasmuch as the pressure P_C is essentially

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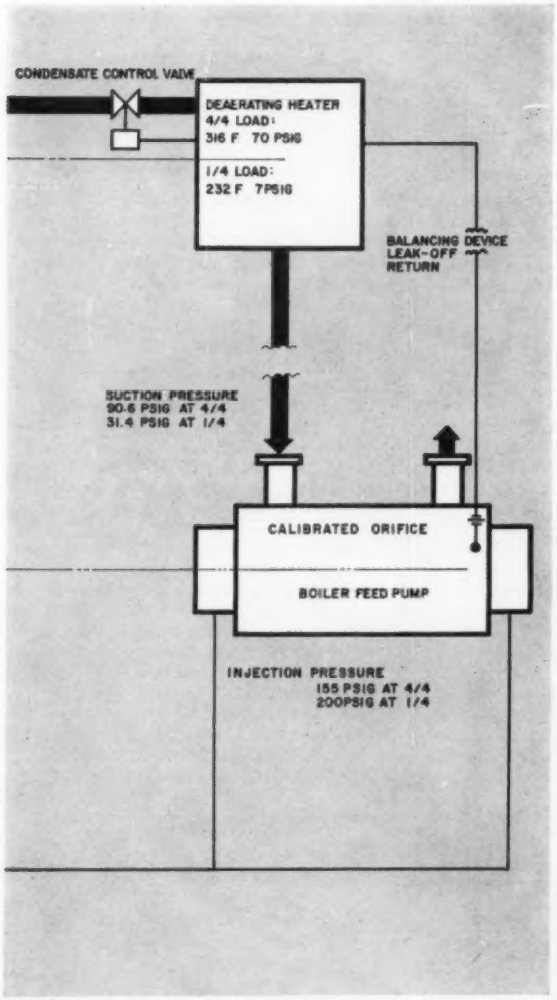


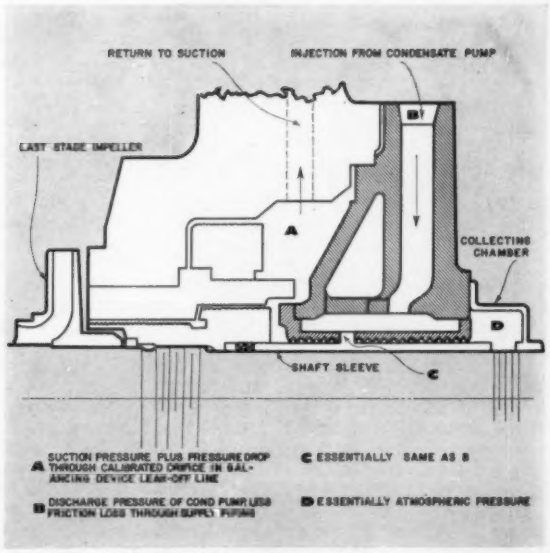

RETURN TO SUCTION
INJECTION FROM CONDENSATE PUMP
LAST STAGE IMPELLER
COLLECTING CHAMBER
SHAFT SLEEVE
A SUCTION PRESSURE PLUS PRESSURE DROP THROUGH CALIBRATED ORIFICE IN BALANCING DEVICE LEAK-OFF LINE
C ESSENTIALLY SAME AS B
B DISCHARGE PRESSURE OF COND PUMP LESS FRICTION LOSS THROUGH SUPPLY PIPING
D ESSENTIALLY ATMOSPHERIC PRESSURE

Fig. 1. (*Left*) Schematic diagram showing application of injection packless stuffing boxes to open feedwater cycle and pressure distribution at full and one quarter full load

Fig. 2. (*Above*) Section through packless stuffing box on the discharge (balancing device) side, to illustrate text explanation of pressure variations under different conditions

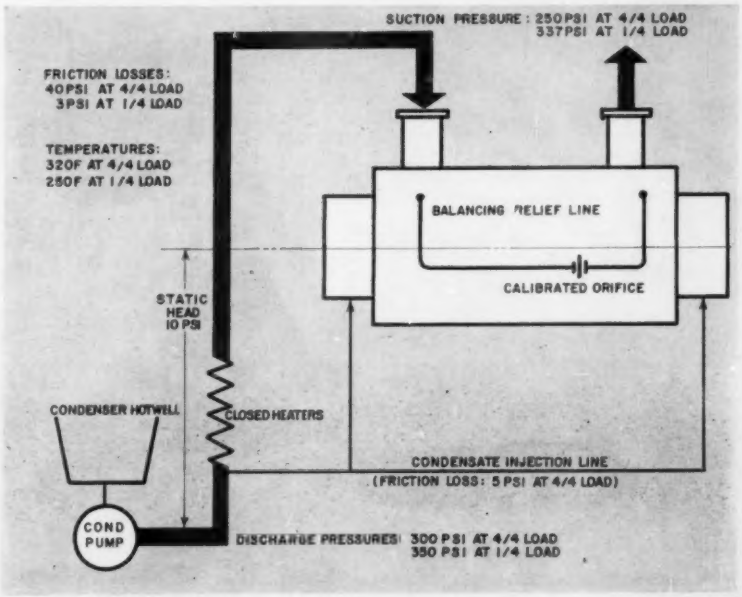
Fig. 3. (*Below*) Schematic diagram showing application of injection packless stuffing boxes to closed feedwater cycle and pressure distribution at full and one quarter full load

the same as the pressure at the injection point, it also exceeds the pressure in the balancing device relief chamber and flow takes place inwardly from point (C) to point (A) as well as outwardly from point (C) into the collecting chamber (D).

As the load is reduced, the friction losses between the condensate pump and the main feed pump decrease approximately with the square of the capacity. Thus at some extremely low pump loads, the boiler feed pump suction pressure may be but 1 or 2 psi lower than the condensate pump discharge pressure (neglecting the static elevation difference which is the same for both suction and injection piping).

A typical example of what happens is shown on Fig. 3. At full load, there is ample excess pressure in the injection line to produce flow into the pump. When the load is reduced to ¼ flow, the following situation prevails:

1) **At the suction side,** the suction pressure becomes 337 psi while the



discharge pressure of the condensate pump less the static head is 340 psi. If the injection flow remains essentially unchanged and the friction losses in the injection piping are still assumed to be 5 psi, the available injection pressure is reduced to 335 psi — less than the suction pressure by 2 psi.

2) **At the discharge side,** the pressure in the balancing device relief chamber is equal to the suction pressure plus the loss through the calibrated orifice in the balancing relief line which is used to measure the leakage past the balancing device. When the pump is new, this loss is approximately 5 psi and the pressure in this chamber at 4/4 load is 255 psi. The injection line pressure is 285 psi and 30 psi differential is available to cause inward flow of injection water. At ¼ load, the pressure in the relief chamber is 342 psi, while the injection line pressure is only 335 psi, less than the relief chamber pressure by 7 psi.

If the pump is worn and the pressure drop through the calibrated orifice is permitted to go up to 35 psi, the relief chamber pressure will become 285 psi, balancing exactly the injection line pressure. At ¼ load, the relief chamber pressure becomes 372 psi while the injection pressure is only 335 psi. Thus, when a pump is worn, no excess pressure exists between the injection pressure and the relief chamber pressure under *any load conditions.*

What actually does take place, then, in the packless stuffing box under these conditions? Referring again to Fig. 2, as the difference between pressures at C and A diminishes, less and less flow takes place inwardly from point C to point A. Finally, a condition prevails when pressure at A slightly exceeds pressure at C. At that time, a small amount of feedwater flows from point A to point C and mixes with the injection water. The mixture proceeds as before towards the collecting chamber, from which it is returned to the condenser.

Because of the breakdown provided between points A and C and because the pressure differential between points A and C is only a fraction of the pressure differential between points C and D, the amount of this "reverse" flow is relatively small and should not raise the temperature of the mixture appreciably. Thus, even though the reduction of the pressure drop between the condensate pump discharge and the boiler feed pump suction results in a change of direction of flow between points C and A, the operation of the packless stuffing box remains acceptable.

The outline of the events presented above eliminated the effect of the balancing device itself on the pressure at point A for the sake of simplicity. It may be interesting to mention that this balancing device develops a pumping action so that the pressure at the shaft sleeve near point A is actually some 20 to 30 psi under the pressure at the periphery of the relief chamber. This is very graphically illustrated on Fig. 4 which shows the inward leakage (from C to A) under varying pressure differences between injection line and the relief chamber. Paradoxically, some flow still takes place inwardly, even though the pressure difference is negative, as long as the pump is running. When the pump is idle, of course, this condition disappears.

Of course, if it is desired to maintain a condition where the flow of injection water will always take place from point C inwardly to a point A regardless of the load, a small booster pump should be installed in the injection line, taking its suction from the condensate pump discharge and raising that pressure by some 50 psi.

It should be noted that when the pump is idle, no flow takes place through the balancing device and the inward pressures at the suction and discharge sides are essentially equal. Thus, there should be no problem in maintaining inward sealing flow to a pump which is kept idle on standby service and fully warmed up, ready for instantaneous start-up.

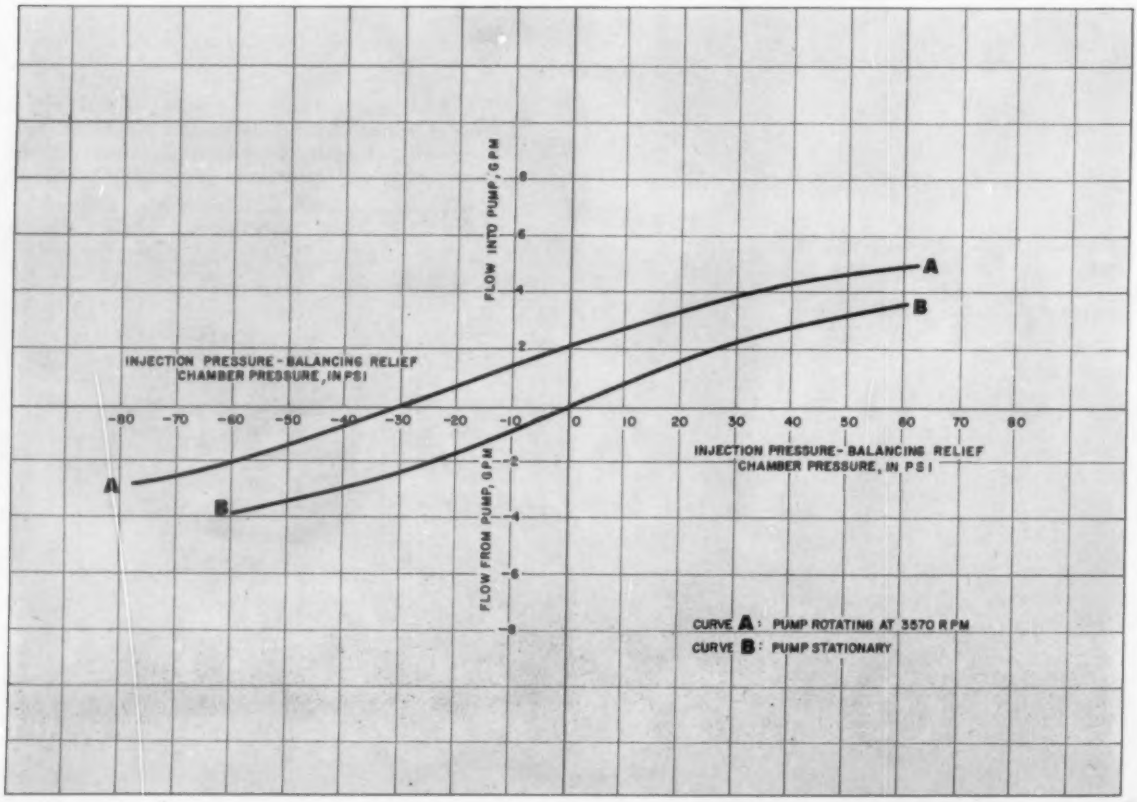


Fig. 4. Showing effect of pump rotation on injection flow into pump. Chart illustrates pumping action of balancing device

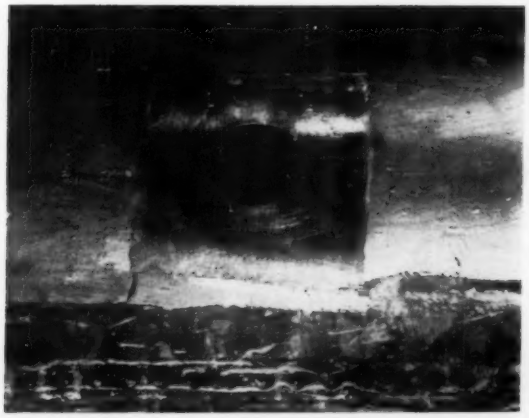


Fig. 1. A 3-in. diam hole is cut with surrounding metal abraded clean and washed with cleaner supplied in kit

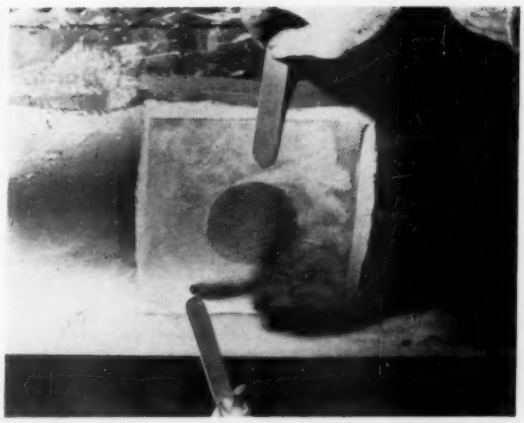


Fig. 2. Glass cloth patch is pressed firmly into the prime coat. Patch is then thoroughly coated with Sonite P-2

Fig. 3. 2nd glass cloth patch is applied, repeating operation. Extend coated area beyond patch for firm adherence

Fig. 4. Final layer is coated heavily and allowed to harden. Hardened patch may be filed or sanded smooth

You Can Repair Tanks Without Welding

HAZARDS AND difficulties involved in making welded repairs to metal tanks, pipes, and conduit have long been troublesome in many industries. This has been especially true where flammable materials are being handled, and complete evacuation of all liquids, gases, or powders becomes necessary before welding can be started. A method for making such repairs without welding, using glass cloth and a newly-developed epoxy resin material, called Sonite, has now been perfected.

Patches made in this way have been tested to over 1000 psi for extended periods without failure. Corroded or broken-out areas, split seams, breaks, and porous areas can be quickly, easily, and effectively repaired in tanks, pipes, or conduit handling gasoline, fuel and lube oils, acids, alkalis, and, in fact, practically any liquid, gas, or powdered material.

Sonite has great chemical stability and good adhesion to metals; it is oil and waterproof, resists acids and alkalis, and will withstand temperatures to 200 F. It is available in white, designated as Sonite P-2, and aluminum, designated as Sonite P-5.

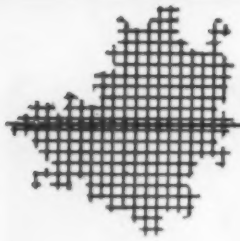
A typical tank repair is shown in the accompanying illustrations. The repair is being made with material supplied in a Sonite kit containing all needed materials, including glass cloth, stirring paddles, brush and brush cleaner, and compound.

First the hole and surrounding areas are cleaned down to bare, firm metal and washed with the brush cleaner to remove all oil and grease. When the metal is dry, a primer, supplied with the repair kit, is mixed and painted onto the patching area and allowed to get tacky-hard. This takes about a half-hour at 70 F. Then a glass cloth patch of the proper size is placed into position and pressed into the prime coat.

Sonite, mixed according to directions, is painted over the glass cloth, making certain that it is brushed over the patch edges. A second patch is then placed over the first and the painting operation repeated. Two glass cloth layers will take care of a hole in a small tank or pipe; three or four are recommended for large tanks or pipes, or for use with acids or alkalis.

A neater job will result if successive patches are cut slightly larger, thus feathering the edges as the patching progresses. If desired, the completed and hardened patch can be filed or sanded smooth. The patch will harden and the tank or pipe can be used in 18 hours at room temperatures. External heat must be applied if the hardening is to take place properly in cold weather, or if the situation requires a faster cure.

Additional information as to uses and availability of Sonite P-2 or P-5 Repair Kits and other epoxy resin compounds can be obtained by writing the Editor.



Graphical Boiler Heat Balance

This is the last article in the Graphical Boiler Heat Balance series. Previous articles gave losses due to incomplete combustion, losses in dry flue gases, losses due to the hydrogen in the fuel, losses due to moisture in the fuel, and due to radiation from boiler and setting

Heat Absorbed by Steam Generating Unit

BY PAUL J. GROGAN*

KNOWLEDGE of the per cent of fuel energy absorbed by the steam generating unit is the ultimate goal in performing a boiler heat balance. In design work, the heat absorbed by the steam generating unit is obtained in an indirect manner. The several losses (discussed in earlier POWER ENGINEERING articles *) may be estimated in terms of design criteria.

The standard heat balance formulas or graphical methods encouraged herein may be used to evaluate the several items in terms of assumed gas and air temperatures, fuel and gas analyses, and refuse and unaccounted losses. The heat absorbed by the steam generating unit is then found by difference, or 100 per cent minus the summation of the losses.

The direct method of heat balance inquiry, as used in actual performance testing, gives the per cent of fuel energy absorbed by the steam generating unit in terms of the lb of steam produced per lb of fuel and the heat absorbed per lb of steam. The required data includes no less imposing array of information than:

1. steam pressure at boiler or superheater outlet
2. steam temperature at superheater outlet or quality at boiler outlet
3. feedwater temperature to economizer or boiler
4. lb of water evaporated per lb of fuel
5. higher heating value of fuel in Btu per lb.

The requisite steam properties have been plotted on the accompanying construction for steam pressures to 1600 psia, steam temperatures to 1100F, and for feedwater temperatures between 100F and 500F. The properties of steam used herein are based upon values taken from Keenan and Keyes, Thermodynamic Properties of Steam, John Wiley and Sons, Inc., New York, N. Y., 1936, and appear with the permission of the publisher. The lower portion of the diagram then yields such additional information as the enthalpy of the steam at the boiler or superheater outlet, the somewhat antiquated factor of evaporation, and the net heat absorbed per lb of steam.

The elusive item of pump work has not been considered in this construction. Neither have we developed methods for reheat or double reheat cycles.

A steam generation unit receives 300F feedwater and produces superheated steam at 600 psia and 700F. Find the initial heat content, the factor of evaporation, and the net Btu absorbed per lb of steam in passing through the unit.

Solution: Enter the lower part of the diagram at 600 psia (Point A) and proceed vertically until intersecting the line of 700F steam temperature (Point B). The heat content at the superheater outlet is read at the left (Point C) as 1350 Btu per lb. The value taken from the steam tables is 1351.1 Btu per lb.

From Point B, move to the right until intersecting the line of 300F feedwater temperature (Point D) and then trace a line vertically to the margin labeled net heat absorbed per lb of steam (Point E). The value is read as 1080 Btu per lb. The steam tables give 1081.5 Btu per lb for this item in terms of the stated water and steam conditions. The 1.5 Btu error at this point represents a satisfactory overall accuracy of 99.86 per cent; an accuracy well within the width of the construction lines.

A dotted reference line has been given for converting the net heat absorbed per lb of steam into factor of evaporation if that information is desired. The evaporation of 212F saturated water to 212F dry and saturated steam requires an input of 970.3 Btu per lb. This quantity of heat once was popularly used as a unit of heat absorption. Point F on the diagram marks the intersection of the earlier construction line with the reference line for obtaining the factor of evaporation. For the conditions of this problem, read the answer 1.11 (Point G) at the right-hand margin.

The lower part of the graph may be used for a great many other problems involving the properties of steam. Quick visual checks may be made for the influences of steam pressure, steam temperature, and feedwater temperature upon the total and net heat content of the steam passing through a unit under different design conditions.

The upper half of the diagram is used to translate information about the heat absorbed per lb of steam and the lb of water evaporated per lb of fuel into steam generator efficiency by taking into account the higher heating value of the fuel:

$$\text{Efficiency} = \frac{\frac{\text{Btu}}{\text{lb. steam}} \times \frac{\text{lb. steam}}{\text{lb. fuel}}}{\frac{\text{Btu}}{\text{lb. fuel}}} = \frac{\text{Btu}}{\text{Btu}} \text{ (a dimensionless ratio)}$$

The calculation is checked out dimensionally above. The graphical solution performs the multiplication of Btu per lb of steam by lb of steam per lb of fuel and then the division by Btu per lb of fuel. The dimensionless ratio, Btu per Btu, is the steam generator efficiency expressed as a decimal fraction. The chart employs an automatic multiplier of 100 to convert decimal answer to per cent.

The necessary additional data for the graphical solution is given below:

1. Btu per lb of steam = 1080 Btu per lb (from earlier graphical solution)
2. Evaporation = 10.5 lb (assumed for purposes of this problem)
3. Higher Heating Value = 13,500 Btu per lb (assumed for purposes of this problem).

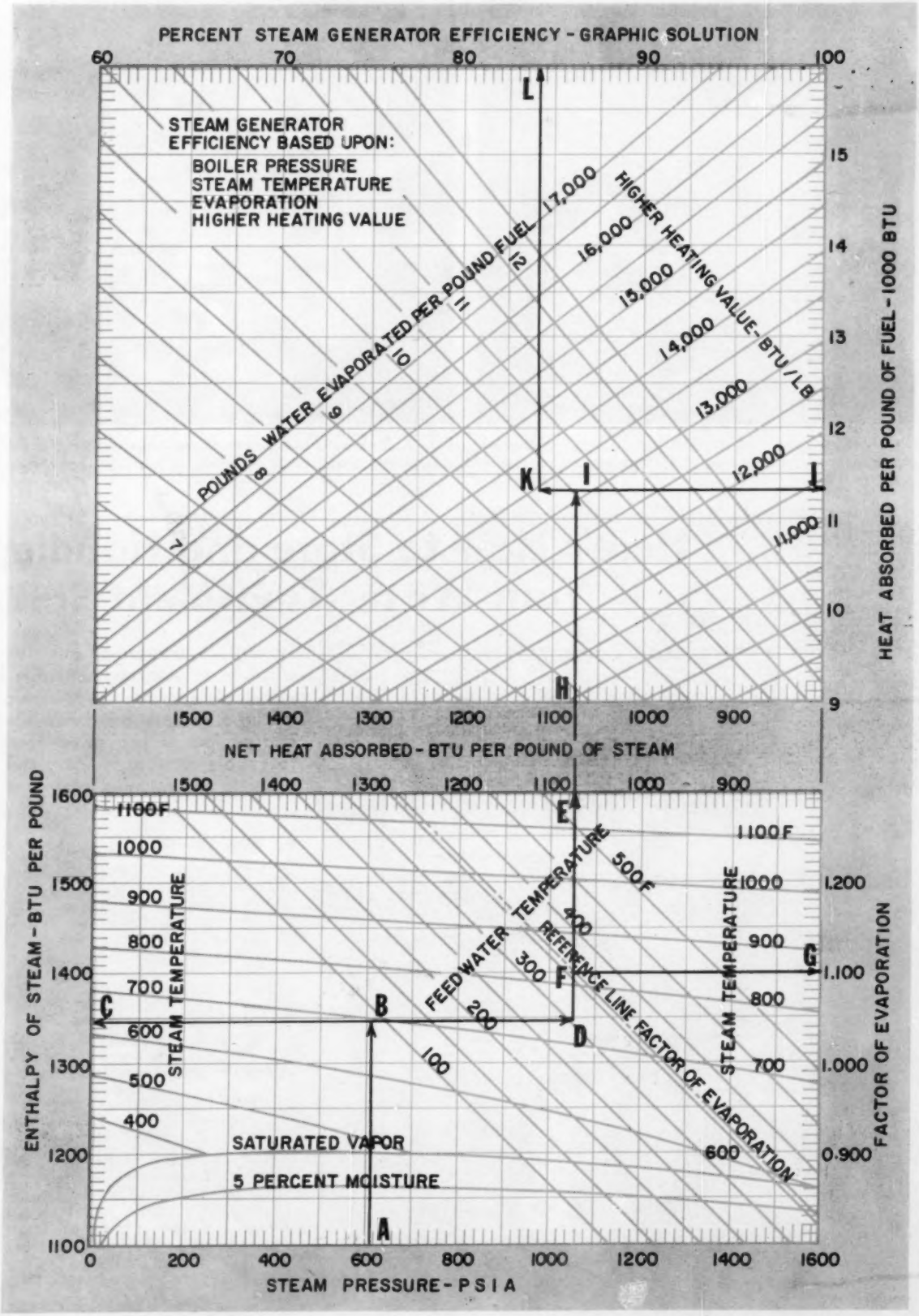
Enter the upper portion of the diagram at 1080 Btu per lb (Point H). Proceed vertically until intersecting the line of 10.5 lb of water evaporated per lb of fuel (Point I). The scale at the right gives the additional bit of information, heat absorbed per lb of fuel. For the purposes of this example, that value is 11,350 Btu per lb (Point J).

Returning to the problem at hand, trace a horizontal line from Point I to the line representing the 13,500 Btu per lb higher heating value of the fuel (Point K). The final answer is read (Point L) as 84.0 per cent by tracing a vertical line to intersect the scale across the top.

Again, the upper half of the chart may be used to solve a wide range of problems involving the efficiency of units. Given the net heat absorbed per lb of steam, the evaporation, and the higher heating value of the fuel, the per cent steam generator efficiency follows immediately. Or the problem may be worked in reverse to solve for any one variable in terms of the other three.

* Losses due to moisture in the fuel, April 55; losses due to hydrogen in the fuel, Aug 55; dry flue gas losses, Sept 55; losses due to incomplete combustion, May 56; losses due to radiation, June 56.

*Chairman, Department of Engineering, and Director of Engineering Institutes, University Extension Division, University of Wisconsin. All re-publication rights reserved by author.


PERCENT STEAM GENERATOR EFFICIENCY - GRAPHIC SOLUTION
STEAM GENERATOR EFFICIENCY BASED UPON:
BOILER PRESSURE
STEAM TEMPERATURE
EVAPORATION
HIGHER HEATING VALUE
POUNDS WATER EVAPORATED PER POUND FUEL
HIGHER HEATING VALUE - BTU / LB
HEAT ABSORBED PER POUND OF FUEL - 1000 BTU
NET HEAT ABSORBED - BTU PER POUND OF STEAM
ENTHALPY OF STEAM - BTU PER POUND
STEAM TEMPERATURE
FEEDWATER TEMPERATURE
REFERENCE LINE FACTOR OF EVAPORATION
FACTOR OF EVAPORATION
SATURATED VAPOR
5 PERCENT MOISTURE
STEAM PRESSURE - PSIA

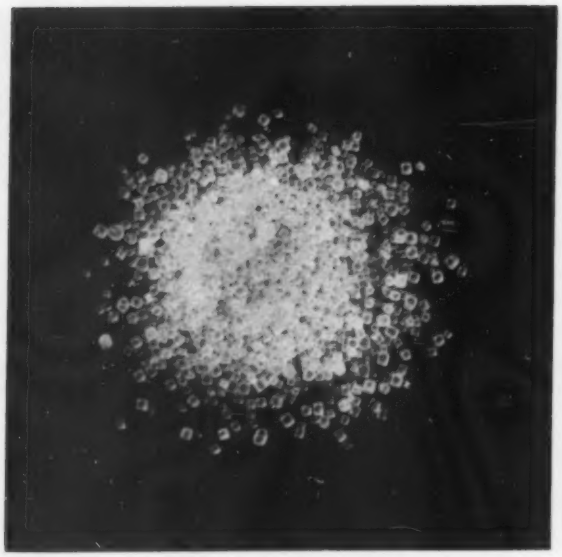


Fig. 1. Evaporated salt crystals are uniform in structure, dissolve quickly, completely, but absorb moisture readily

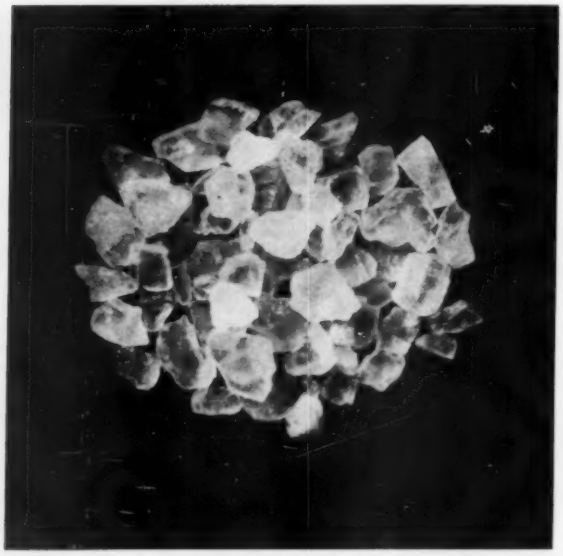


Fig. 2. Rock salt, like pieces shown here, is irregular in size, may contain other elements, is relatively anhydrous

Here's How to Store and Handle Your Water Treatment Salt

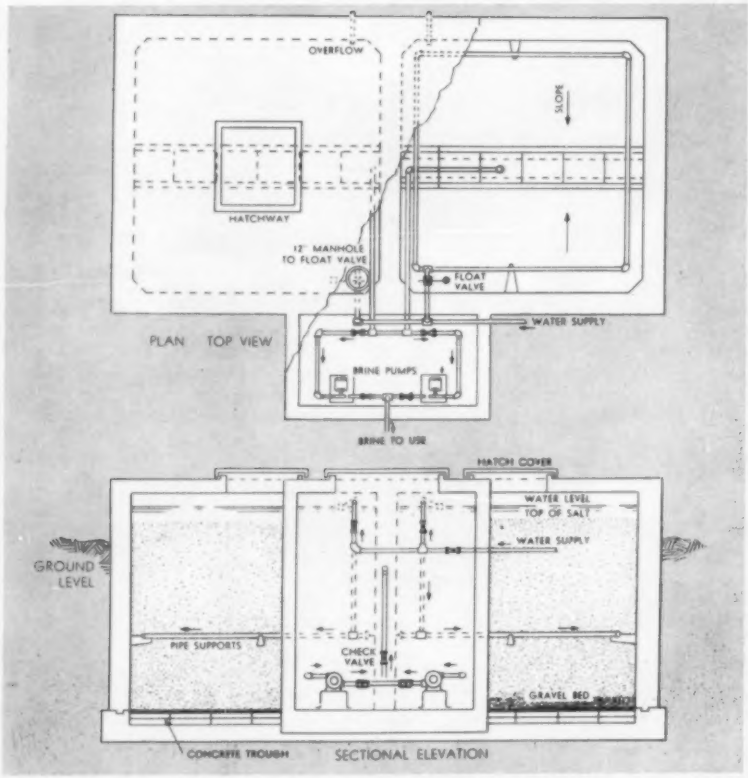


Fig. 3. Drawing shows construction of typical storage system for wet rock salt. Double tank design makes cleaning, necessary in rock salt storage, easy matter

Storing regenerating salt for water treatment can be troublesome unless proper procedures are used. Recommended methods and equipment are given here to enable you to simplify the problem and cut your labor cost

By DON HEATH*

SINCE THE COMING of modern high-capacity ion-exchange materials, such as polystyrene resin, the power-plant water treatment equipment operator has been using salt more and more as a regenerating chemical. With the use of salts on the increase, it is in some cases becoming a major storage and handling problem for the power plant.

The following figures (short tons) will illustrate the increased use of salt in the field of water treatment:

Type of Salt	*1952*	*1954 (estimated)*
Evaporated	282,000	330,000
Rock	338,000	400,000

Both evaporated and rock salt are used, depending on the requirements of the power plant. The essential differences between the two salts are: Evaporated salt is more uniformly consistent as to grain size and quality; it is 100 per cent soluble; and storage and dissolving equipment

* Industrial Specialist, Morton Salt Co.

require a minimum of maintenance and cleaning.

Rock salt is coarser grained, with its quality depending upon its source. It has a varying percentage of insoluble impurities, but its storage characteristics are less affected by moisture and it is a freer-flowing salt for self-feeding storage systems. Rock salt, in some regions, is also less expensive than evaporated salt.

Once the power plant operator has determined the type and quantity* of salt he will need, he must then survey delivery methods. Delivery can be made in 100 lb bags or in bulk form, by truck or railroad car.

Because it is a great portion of the delivered chemical's cost, freight cost will have bearing on the size and method of delivery. The local salt sales representative can furnish all freight rates and all jobber sources of supply. Delivery time is 5 to 7 days for a rail car of salt, but for effective scheduling the car should be ordered 15 to 20 days in advance of expected delivery date.

If both rail and truck delivery are possible to the plant site, the efficiency of handling to storage is quite often the determining factor in the choice of method of delivery.

*See "Figure Regeneration Salt Consumption With This Graphic Guide," POWER ENGINEERING, March, 1956

Unloading Salt

Closely tied in with the method of delivery are facilities available for unloading, ranging from entirely manual to completely power operated.

When bags of salt, delivered by either truck or rail car, are stacked on pallets, fork-lift trucks are usually the fastest means of unloading. Other methods are hand carrying, carts, dollies, or roller conveyors.

In unloading bulk truck or rail-car shipments several methods are available. In some areas, where bulk salt is delivered by truck, the truck carries a portable conveyor, either of the belt or the auger type. When this is not available it is wise to provide a conveying or handling system that will cut labor to a minimum.

Table I compares briefly the general specifications of both types of conveyors used for this purpose.

If we assume that most power plants have some form of a conveyor available, there are several types of equipment that can be used in conjunction with the conveyor.

The common scoop shovel may be used, or an enlarged version of it called a grain scoop, which has two small wheels at the back of the bowl. The grain scoop will hold up to 150 lb, where the scoop shovel holds only about 20 lb.

Probably the most efficient method of unloading bulk salt is the industrial scoop truck, which can be gas or electric powered. This is similar to the fork lift truck, and in many cases, one unit may be used with a scoop attachment or a fork lift.

Thus, such a unit may be used for general service around the power plant for other tasks. There is also the advantage that where a fork lift truck is used for handling palletized salt bags, a change to bulk salt may mean only the addition of a scoop

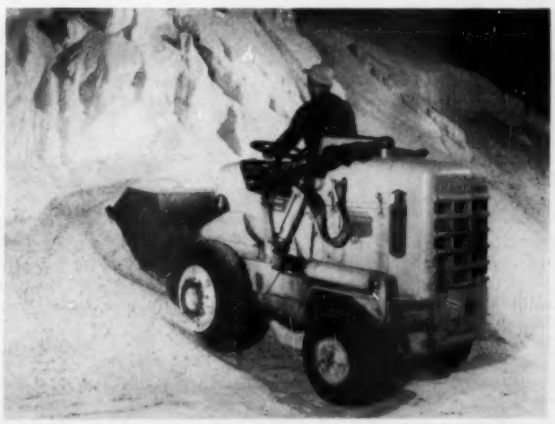


Fig. 4. (Right) Where large quantities of salt are stored in dry bulk form, the small industrial scoop truck—gas or electric—will pay off investment in savings on labor

Fig. 5. (Below, left) Semi-wet storage in bulk. Floor and lower wall should be given several coats of tar to protect the concrete and blocks in contact with wet salt and brine

Fig. 6. (Below, right) Top of double basin wet storage tank. Concrete ramp at lower left corner of picture is driveway for trucks; this provision makes delivery of bulk salt easy

Table I. A general comparison of belt and auger conveyors for handling salt

Specification	Belt type	Auger type
Length	12 to 18 ft	12 to 18 ft
Construction	rubber belt trough between aluminum or steel	steel
Delivery	20 tons per hr speed	6 tons per hr
Maximum delivery angle (from horizontal)	30 deg	90 deg

attachment rather than the purchase of a whole new truck unit.

The scoop truck may also be used without the conveyor system since the salt can be transported directly to the storage area or the area where it is to be used.

Power plants that are using only the most basic unloading equipment may find that, in the long run, they will save money by purchasing power unloading equipment. The graph in Fig. 7 shows the estimated differences in unloading times using varied equipment.

When salt is shipped in bulk form, it takes from 1½ to 3 hours to clear a boxcar manually so unloading equipment may be used to advantage inside the car.

A storage space or system can be planned only after consideration and determination of size and methods of delivery and handling.

Table II can be used as a guide in estimating storage unit size. Those plants consuming not more than 400 tons of salt per year can expect these figures of capacity to apply. Power plants that consume 500 tons per year or more, with a probable wet or semi-wet salt storage system of 120- to 200-ton capacity, should consider covered hopper car delivery.

Wet and Semi-Wet Storage

In wet salt storage, the salt is completely immersed in water at all times. In such a storage arrangement, the salt will store at a rate of 82 to 85 lb per cu ft. Not only does such a unit serve as storage, but it also makes brine at the same time, which saves greatly on re-handling labor and cost. Either evaporated or rock salt can be used, and while a wet salt storage installation is initially more expensive than one for dry salt storage, this type of system is a long range investment. A wet salt storage installation will, with proper care, have a life expectancy of 20 to 30 years.

Much of this longevity depends on the quality of the concrete used in the construction of the underground basin. Better construction means greater utility and longer life for the installation.

To assure the delivery of a saturated brine solution at all times, it is a good rule of thumb to make the capacity of the storage unit 1½ times the minimum delivery size.

In semi-wet salt storage, most of the factors influencing wet salt storage apply also. This type of unit serves the dual job of storage and brine making. It differs mainly in that it is used with grades of rock salt only, and only the salt in the bottom center trough is immersed in water. In a semi-wet storage unit, water is best entered at a point in elevation that is at mid-depth of the trough.

Factors applicable to both types of storage are that, for the sake of convenience and efficiency, the storage unit should be within easy pumping range of the water treatment equipment. In wet or semi-wet storage with rock salt, a double basin unit should be used, so that a steady flow of brine is assured when one basin is closed down for cleaning.

Dry Salt Storage

Using a dry salt storage arrangement presents an entirely different set of factors for consideration. Dry salt, in bag form, stores at a rate of 50 lb per cu ft, while dry bulk storage rate is 70 to 75 lb per cu ft.

While it is convenient to have the storage area as close to the dissolving equipment as possible, it also must be isolated from any metallic

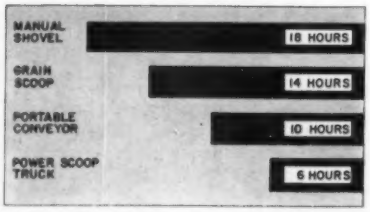


Fig. 7. Manhour savings with equipment

operating equipment because of salt's corrosive properties.

Another factor to consider in dry storage is that all commercial salt is hygroscopic when stored and subjected to relative humidities exceeding 76 per cent. For this reason it is necessary to keep the storage area as moisture-free as possible.

When storing salt bags it is advisable to stack them no higher than 10 ft, and to allow for free circulation of air around all four sides and underneath the stacks. This may be done by stacking the salt on wooden platforms and allowing air space between stacks. Bag salt should not be stored directly on concrete floors or against exterior walls.

Bulk salt can be stored in wood-lined brick or block bins, with air space between the wood and brick floors and walls. Air circulation is a less critical factor in the case of the coarser grained rock salts.

If elevation space allows, an ideal arrangement is to have the bulk salt storage bin directly above the dissolving equipment, whereby a self-feeding chute or hopper can be used. For a self-feeding arrangement it is necessary to know the angle at which bulk salt will flow when stored in low humidity conditions. For evaporated salt the angle of repose is 45 to 50 deg, and for rock salt it is 35 to 30 deg.

Summary

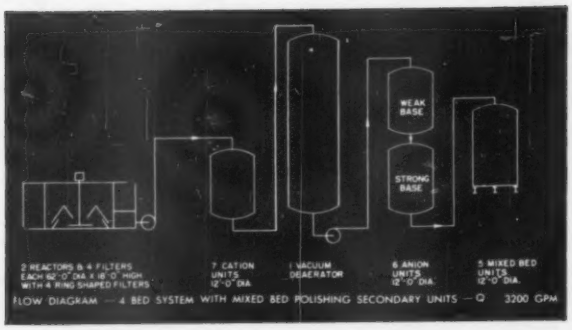
The following step-by-step summary may be used as a guide in planning a salt handling and storage system, initially, or to already existing facilities:

1. Determine the yearly consumption of salt for the power plant
2. Determine the type of salt to be used
3. Determine whether salt is to be shipped in bags or bulk
4. Analyze and choose the best method of delivery, based on existing facilities
5. Analyze handling factors, with a view to the possible purchase of new equipment
6. Determine the type of storage, whether it is to be wet, semi-wet, or dry
7. Decide what capacity the storage unit is to be
8. Analyze space available and decide on the storage unit placement.

Table II. Guide for estimating storage unit size; figures shown refer to short tons

Delivery method		Bag	Bulk		
		Dry	Wet	Semi-wet (dual chamber)	Dry
Plant direct	Rail	30	60 to 90	50 each basin	50
	Truck	15	30	17 each basin (35 total)	25
Metropolitan warehousing service	Rail	----- Not available -----			
	Truck	1 to 5	10	2 to 6 each basin (12 total)	8

First in water conditioning


WEAK BASE
STRONG BASE
2 REACTORS & 4 FILTERS EACH 62'-0" DIA X 18'-0" HIGH WITH 4 RING SHAPED FILTERS
7 CATION UNITS 12'-0" DIA
1 VACUUM DEAERATOR
6 ANION UNITS 12'-0" DIA.
5 MIXED BED UNITS 12'-0" DIA.
FLOW DIAGRAM — 4 BED SYSTEM WITH MIXED BED POLISHING SECONDARY UNITS — Q 3200 GPM

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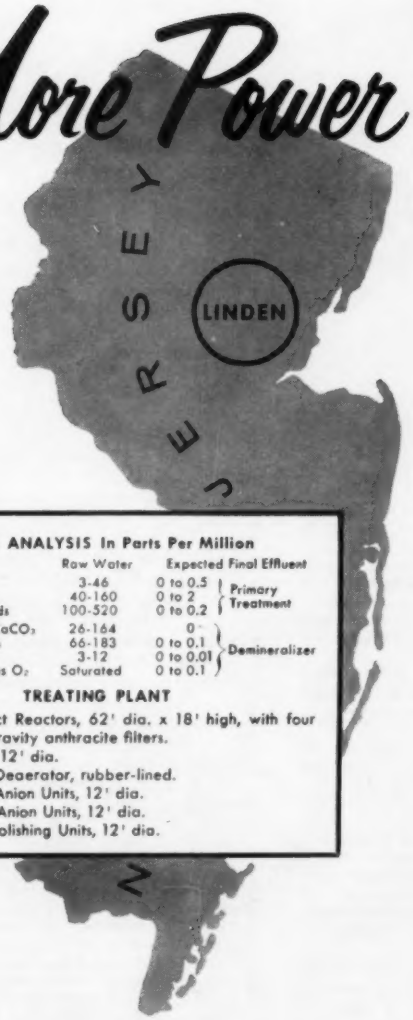

WATER ANALYSIS In Parts Per Million

	Raw Water	Expected Final Effluent	
Turbidity	3-46	0 to 0.5	Primary Treatment
Color	40-160	0 to 2	
Total Dissolved Solids	100-520	0 to 0.2	
Total Hardness as $CaCO_3$	26-164	0	Demineralizer
Alkalinity as $CaCO_3$	66-183	0 to 0.1	
Silica as SiO_2	3-12	0 to 0.01	
Dissolved Oxygen as O_2	Saturated	0 to 0.1	

TREATING PLANT

2—Solids-Contact Reactors, 62' dia. x 18' high, with four peripheral gravity anthracite filters.
7—Cation Units, 12' dia.
1—14' Vacuum Deaerator, rubber-lined.
6—Weak Base Anion Units, 12' dia.
6—Strong Base Anion Units, 12' dia.
5—Mixed-bed Polishing Units, 12' dia.

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"EMINENCE" ...Open Door to Engineers' Registration

By JOHN D. CONSTANCE*

YOU ARE AN ENGINEER. You graduated from a recognized engineering school and have practiced engineering for the past 18 years. You now decide that it would be a good idea to become a *registered* engineer. Must you take a written examination? Perhaps not.

Practically all state registration laws have been so drafted that written examinations for registration of properly qualified engineers with many years of eminent practice may be waived. However, there seems to be a wide divergence of opinion as to what constitutes "eminence". It must be recognized that there are all degrees of eminence, and, if the most stringent rules were applied, very few men would qualify in this category.

While a great many engineers may not be eminent in the strictest sense of the word, many of them are very competent in their particular fields, and recognition of that competence by their associates can take several forms.

Many boards of examiners may waive specific requirements for qualifications, except those of age, character, and citizenship, for applicants who possess long established practice and recognized standing in the profession, and who have practiced engineering for more than 12 to 25 years after graduation from an approved school of engineering. The several state laws do not spell out "eminence" for the boards, but do stipulate that such a candidate shall be over 35 or 50 years of age, as the case may be.

They also state that the candidate shall have the number of experience years to qualify him in this category. While the laws do not set certain minimums regarding age and experience, the boards must review each individual's record for evidence of eminence and recognized standing.

Table: Attitudes toward qualification for engineers' registration on "eminence"

Alabama	No. Not permitted under state law
Alaska	Not eminence, but on exception
Arizona	*Yes.* Experience must be of high quality
Arkansas	Registration on outstanding record, plus oral examination
California	No
Colorado	35 years of age, 12 years of experience
Connecticut	*Yes.* Minimum age, 40 years; 15 years experience; interview
Delaware	*Yes.* 35 years of age, 12 years satisfactory experience
District of Columbia	*Yes.* Recognized standing; 12 years satisfactory experience
Florida	*Yes.* 40 years of age, 15 years of exceptional experience
Georgia	No
Hawaii	*Yes,* but rarely; must have national recognition
Idaho	No
Indiana	No
Illinois	No. No stated rule
Iowa	*Yes.* Discretion of board; require interview
Kansas	*Yes.* Minimum age 35; minimum experience 12 years
Kentucky	*Yes.* 45 years old, long satisfactory experience; four hours oral
Louisiana	*Yes.* 20 years experience
Maine	Minimum age 35; 15 years experience
Maryland	35 years of age; 12 years experience
Massachusetts	*Yes.* Age 35; 12 years experience
Michigan	No
Minnesota	No
Mississippi	*Yes.* 12 years of established practice
Missouri	No
Montana	*Yes.* 12 years experience; 5 years responsible charge
Nebraska	*Yes.* With national reputation
Nevada	*Yes.* All applicants appear before board for oral exam
New Hampshire	*Yes.* 20 to 25 years experience; board to decide
New Jersey	*Yes.* 15 years outstanding experience
New Mexico	Usually depends on circumstances
New York	*Yes.* Discretionary with board; 15 or more years of lawful practice plus recognized standing in profession
North Carolina	*Yes.* 15 years progressive experience, plus oral or written examination
North Dakota	*Yes.* 12 years experience with real eminence and age 35
Ohio	*Yes.* Age 50; experience 25 years; 15 years responsible charge
Oklahoma	No
Oregon	*Yes,* if engineer's experience is long and outstanding
Pennsylvania	No
Puerto Rico	*Yes*
Rhode Island	No answer to question
South Carolina	*Yes.* 35 years of age; 12 years' high experience
South Dakota	No definite policy
Tennessee	Oral exam; written exam waived; discretion of board
Texas	No
Utah	Age 35; 12 years experience; 5 years responsible charge
Vermont	No
Virginia	No
Washington	*Yes.* Each case on its own merits
West Virginia	Rarely
Wisconsin	*Yes.* 35 years of age with 12 years experience
Wyoming	*Yes.* Policy s 40 years of age and 12 years of experience

Source: National Council of State Boards of Engineering Examiners

Waiver of Written Examinations

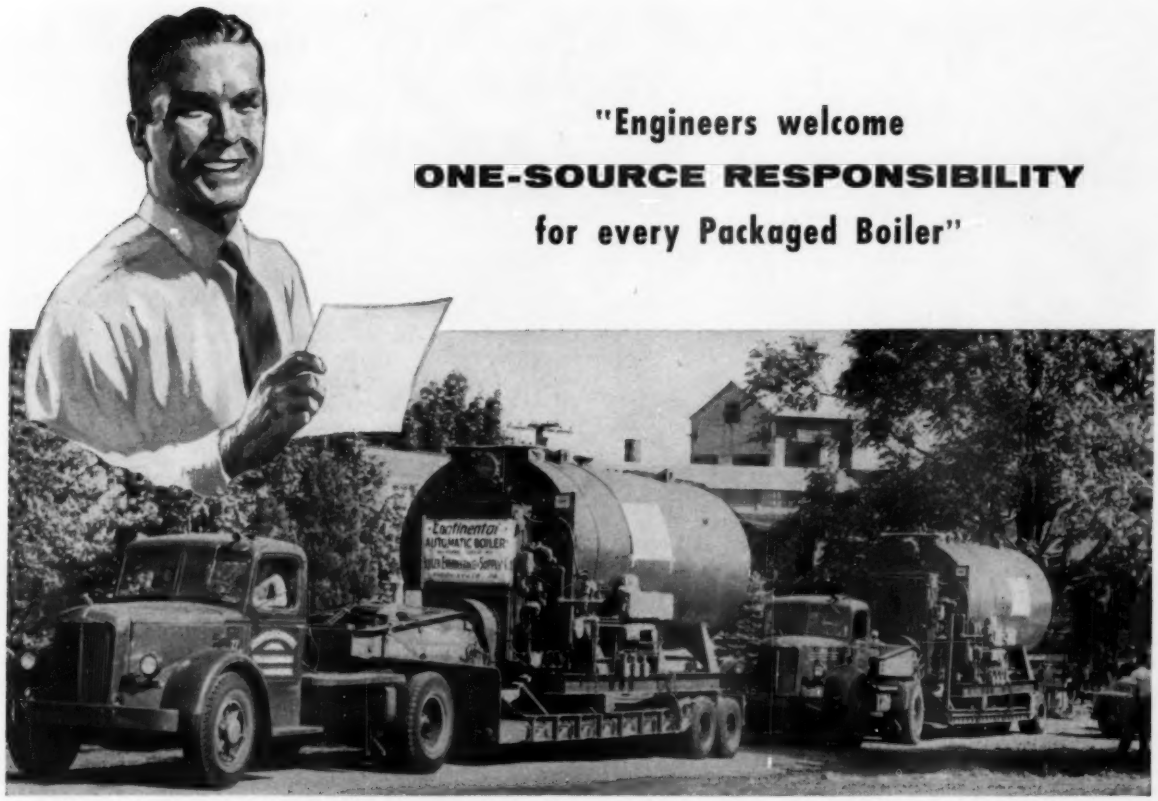
Written examinations are often waived in the case of applicants of long established and eminent practice. This is commonly known as the "eminence" clause in state registration laws. Professional men in this category are the most likely to need multi-state registration for interstate practice. They are also the most likely to have secured their original registration on established qualifications and professional standing without written examinations. They are most likely to be men of outstanding professional qualifications and proven accomplishments. At the same time, by reason of their age, activities, and specialization, they are men for whom the prescribed written examinations are the greatest nuisance and embarrassment.

Certain qualifications may be considered as being evidence of eminence in the engineering profession. Generally, these have been found to be:

1. Demonstrated adherence to high ethical standards

About the Author:

John D. Constance, author of the present article, is making a reputation in the field of professional engineers' registration by conducting a guidance consulting service to help engineers obtain their professional licenses. He renders this service, at what we think is a very moderate and reasonable cost, in the form of refresher courses and advice. These are for engineers who, for one reason or another, do not find it convenient or possible to take the refresher courses conducted by their local engineering societies or colleges. Mr Constance is himself a practicing consulting and, of course, a registered professional enginere. In several previous articles in POWER ENGINEERING, he has given valuable data on engineers' registration, how to fill out the applications for it, how to prepare for the examinations and other phases of the subject. For full information on the ways in which Mr. Constance can help you, and the books and refresher courses he has available, write him at 625 Hudson Terrace, Cliffside Park, New Jersey. It will cost you nothing to learn what he can do for you.



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"As an engineer, I want to know who is responsible for the trouble-free performance of every boiler I specify. With a built-up fire-tube boiler, each component may have a different manufacturer. When service is needed, it's often impossible to pinpoint responsibility.

"But with a Packaged Boiler, it's easy. The company on the nameplate is the one reliable source of responsibility for uninterrupted, smooth, economical functioning of every part. To a busy engineer and a busy plant, the single source of responsibility for Packaged Boiler operation is a factor that cannot be overemphasized.

"So, for completely dependable, low-cost performance . . . and one-source responsibility whenever the need arises . . . I know I can rely on Packaged Boilers for every heating and processing need."

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CONTINENTAL

Automatic Boiler

* Guaranteed 80% efficiency . . . Fire-tested before shipment . . . Range, 20 to 500 hp.
* Simple, practical two-pass design, for uniform flow of combustion gases through all return tubes.
* Maximum radiant heat transfer achieved by "Spinning Gas" technique for thorough mixing of air and atomized fuel.
* High-CO_2 and low-temperature stack gases — proof of high combustion efficiency.
* Free, rapid water circulation improves heat transfer, keeps heating surfaces clean.
* Easy access to furnace and all return tubes. Refractory baffles and brickwork are not required.

For details on the Continental Automatic Boiler, send for Bulletin BE-3

BOILER ENGINEERING & SUPPLY COMPANY, INC.

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A HALF CENTURY OF BOILER MANUFACTURING EXPERIENCE

The Continental AUTOMATIC BOILER

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2. Demonstrated integrity in the practice of the profession
3. Outstanding ability, which might be established by examination of the applicant's record as follows:
a. Responsibility given by his employer
b. Contributions to the technical literature
c. Work on technical committees
d. Patents and important developments and achievements
e. Advanced studies and degrees
f. Respect of fellow engineers
4. Interest in his profession:
a. Membership in technical societies
b. Membership in professional societies
c. Work on education committees such as college or high-school visiting committees
5. Interest in his community:
a. Boy Scouts of America
b. Community Chest
c. Board of Education
d. Parent-Teacher associations
e. Other recognized non-political civic activities

Before an applicant can be considered under the eminence category he may have to show the years of experience in extent and content previously indicated. Non-graduates may also be considered, but in their case the qualification requirements may be even more rigorously applied in addition to an oral examination to determine extent of engineering knowledge, practice, and achievement.

No applicant should consider that the requirements have automatically been met merely because the required number of calendar years have elapsed.

The accompanying table indicates whether or not evidence of eminent practice is accepted for registration by the various states. Nevertheless, it should be remembered that this is an ever-changing situation and questions should be addressed to the state board involved.

This New-Type Fuel Element Increases Reactor Power

MARTIN NUCLEAR Division has announced a highly improved fuel element. Tubular in shape, it is the first to be successfully developed to this stage without the aid of a specific Government contract.

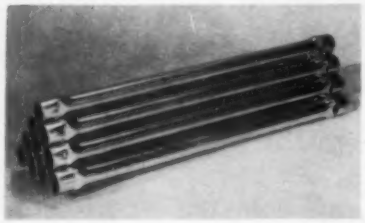
The new fuel element is the first of its kind to undergo tests in the high flux hole of the Materials Test Reactor, Idaho Falls, Idaho. It will impart to some reactors the ability to increase their operating power by 50 per cent and still maintain the same film boiling safety factor.

Several important improvements over a typical flat type element are:

1. Heat transfer surface increases almost 66 per cent.
2. Metal-to-water ratio decreases almost 52 per cent.
3. Flow velocity and pressure drop are reduced by an amount commensurate with the desired increase in operating power.
4. Increased structural strength and rigidity, especially prevalent when the tubes are grouped in bundles.
5. More uniform distribution of fuel.

A tubular fuel element uses small, thin wall tubing. It can best be described as a tube within a tube, with the nuclear fuel between the two tubes. A single tube bundle may have up to 100 tubular elements. The size of the core will determine the number of bundles to be used. A tubular fuel element core is fabricated so that individual bundles can be removed and replaced as necessary.

Thermal and mechanical shock tests were conducted in conjunction with metallographic tests to determine the nature and strength of the bond between core and cladding. Static and corrosion tests were conducted under temperature and pressure conditions more severe than those encountered at the Materials Test Reactor pile, but otherwise duplicating the MTR.



The fuel element shown here increases heat transfer surface nearly 66 per cent

Radiography was used to determine the distribution of the oxide particles in the metallic matrix and also to reveal the presence of any uranium oxide stringers in the fuel core. Zyglo was used to reveal any cracks or surface fissures. Both of these non-destructive testing techniques were developed to satisfy large scale production requirements. Ultrasonic and eddy current testing are presently under study as methods of determining bond uniformity between core and cladding, and to reveal small discontinuities respectively.

Feasibility studies conducted by Martin Nuclear indicate that large scale production of tubular fuel elements can be accomplished at reasonable cost.

Silicon Insulated Cables Operate at 125 C

AT the Hell Gate Generating Station of Consolidated Edison Company of New York, silicon insulated copper cables have been operating successfully since 1954 at temperatures up to 125 C.

When older stations have to be modernized, this new type of insulation permits greater capacity to be obtained from existing equipment and thus helps to solve the problem, faced by nearly every utility in the country, of meeting a rapidly growing electrical load.

Details of the new cables were given at a recent AIEE Meeting by Charles T. Hatcher and A. R. Lee, both of General Electric Co.

The new cables, made with silicon rubber-coated glass tape insulation, are satisfactory for continuous operation at 125C for systems up to and including 15 kv.

These characteristics thus make the cable particularly suitable for increasing the capacity of existing generating stations where space for additional cables is not available or uneconomical to obtain, and they are also extremely useful where high ambient temperatures are causing trouble.

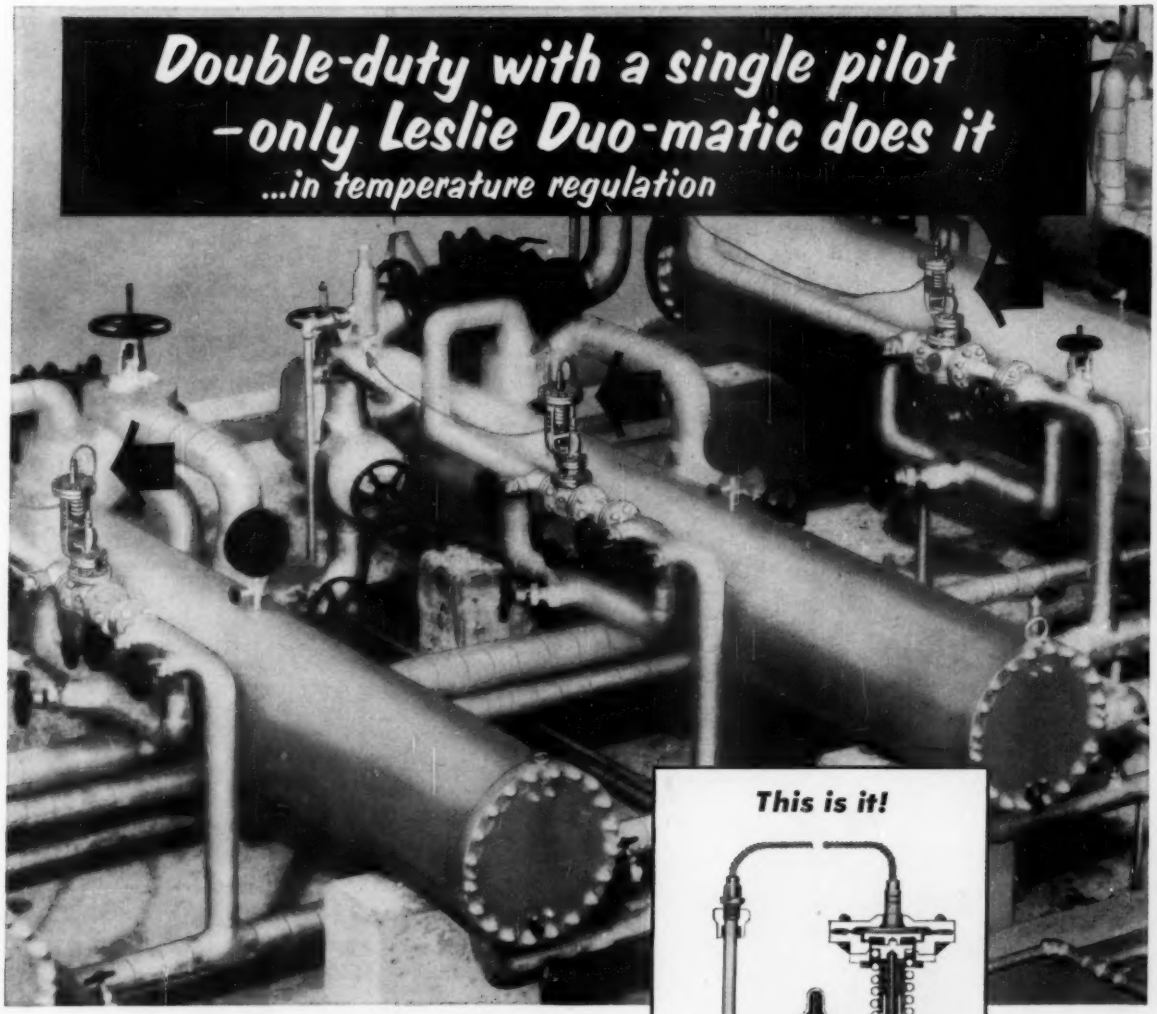
Battery Helps Rotate Bridge 44 Years

THIS 256-cell battery has supplied power for two 100 hp motors for 44 years in the work of rotating Black Rock Bridge on its turntable over the Niagara River at Black Rock, N. Y. The old cells in their lead-lined wooden boxes open to the air were replaced this year with new Gould EW-15 cells fully enclosed in rubber jars with ceramic explosion-proof vent caps and small funnels for replacing water lost through evaporation. Cells are set at a convenient height for easy maintenance. But the 44 years of continuous service of the old cells with their inconvenient positioning have proved what excellent battery care and maintenance can mean to an installation.

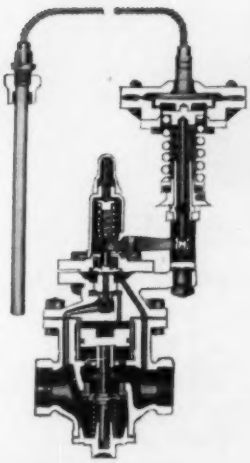
This stationary battery of 356 cells was installed when the bridge was built

Double-duty with a single pilot —only Leslie Duo-matic does it

...in temperature regulation



This is it!



Leslie Class LTCO Duo-matic temperature and pressure regulator

The Duo-matic Leslie temperature regulator for controlling steam flow is a single unit, with a *single* internal pilot valve—yet it controls automatically both temperature and pressure conditions. No hunting or cycling on low flows . . . eliminates temperature "droop" on heavy loads.

Simplified piping and better control of fuel oil heaters, instantaneous and storage type heaters, driers, process heaters, kettles, open tanks, ovens, degreasing machines, steam tables, sterilizers, etc., more than offset the initial cost of this superior regulator.

Investigate "dual-function" Duo-matic regulators — proven in service for over 19 years of applications.

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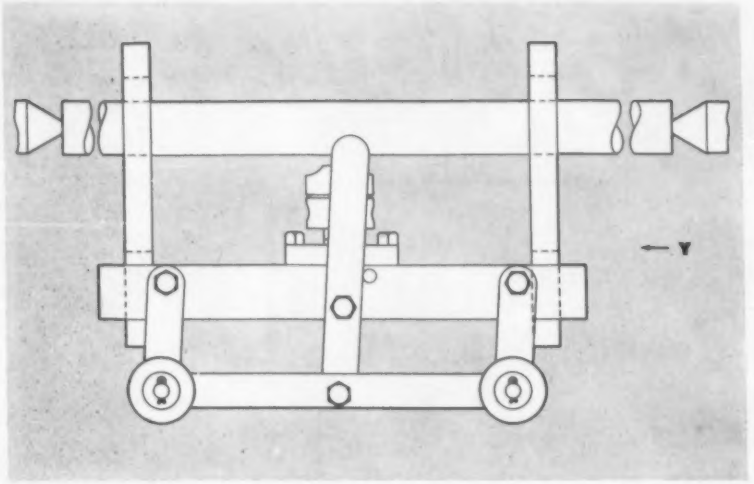

Fig. 1. Wheeled undercarriage in down position, while shaft is rotated to find the high spot of the bend

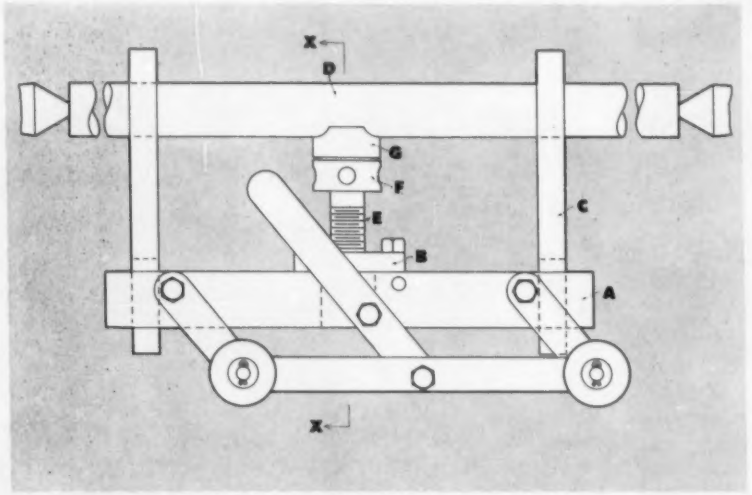

Fig. 2. Straightener with undercarriage retracted. Jack screw is in contact with high spot of bend

fold along this line—outside edges toward you

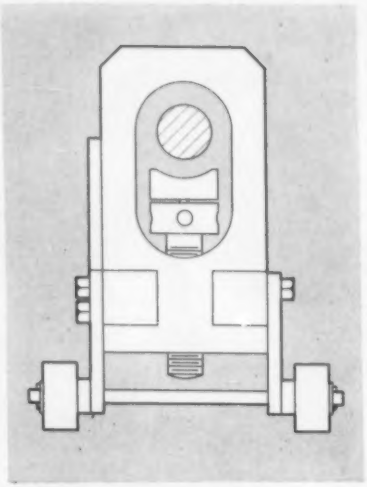

Fig. 1a. End view shows how the shaft is placed in position before the undercarriage is retracted

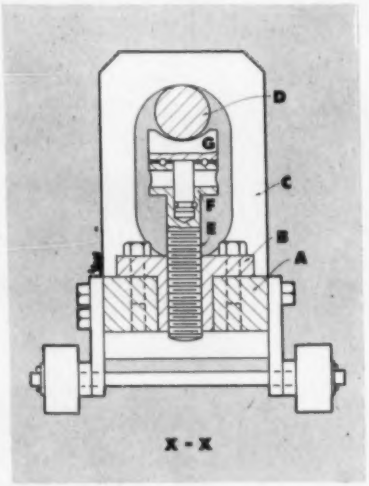

Fig. 2a. Cut-away of end view of straightener in retracted position shows uprights hanging on shaft

Shaft Straightener Safe, Powerful, Labor-Saving

By F. E. RILEY

IN GENERAL ENGINEERING and maintenance work, shafts have to be straightened before machining so that they will clean up. Shafts are often built up by welding and some distortion inevitably results. In the absence of a straightening press, shafts are often mounted in a lathe between centers and are checked for straightness, by revolving them on the centers.

Using a sturdy lathe, it has long been standard practice to find the high spot of the bend in the shaft and to apply pressure to this by means of a lever supported by wood blocks resting on the lathe bed. This practice is bad for the lathe and dangerous for the man hanging on to the end of the lever. The force produced by a manually-operated lever is rarely sufficient to straighten out a shaft of 2-in. diameter, or more, and other dodges are used to help distort the metal. One of these is peening, in which a second man hammers the concave side of the bend to stretch the surface while the lever is acting on the convex side of the bend. Another idea is to apply heat from a torch to the metal while straining with the lever.

These rough methods often yield good results, but apart from the risk of injury to man and machine, they are wasteful of labor and are a poor substitute for good tools which will do the work with greater efficiency.

An efficient straightener, which is adaptable to shafts supported between lathe centers, is illustrated in the drawings. Base of the straightener is formed by the two strong pieces of square-section steel A which are secured together at the center, to form a unit, by means of the flanged nut B.

Slideable horizontally between the bars A are the uprights C which are flame-cut steel plates with large openings cut in them to accommodate bent shafts, such as D. The central nut B has an Acme threaded screw E of as fine a pitch as is consistent with strength. The example shown has a pitch of $\frac{1}{16}$-in.

cut along this line

To 500F it's J-M Interlocked

because it cannot ravel or come apart

Made by an exclusive J-M process, Interlocked packing is braided from tough long-fibre asbestos yarns strongly interlocked in a solid integral structure. There are no jackets to wear through . . . no plaits to loosen. That's why it retains its strength and efficiency far longer than other types.

Interlocked also seals better. It is flexible and resilient, braided square for better contact and requires less gland pressure. Style 255 is effective against steam, hot or cold water, oil, weak acids and caustics. Furnished lubricated and graphited in ring and coil forms in sizes from ¼" and up.

To 750F it's J-M Superheat

because it does not harden under high heat

Designed specifically for superheated steam between 500F and 750F, Johns-Manville's Superheat packing is made of highest quality pure asbestos cloth which retains its resiliency even after long exposure to high temperatures. Woven tight, spiral wrapped and then pressed square, this cloth forms a firm resilient structure of superior strength and wearability.

Style 167 Superheat is bonded with a special heat resistant compound. No excess is present to carbonize in use. Density is carefully controlled for minimum gland pressure. Furnished graphited in ring and coil forms in sizes from ¼" and up.

Your local J-M distributor carries full stocks of Interlocked and Superheat and other packings. Call him today or write Johns-Manville, Box 14, New York 16, N. Y. In Canada, Port Credit, Ontario.

Johns-Manville PACKINGS, GASKETS and TEXTILES

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The upper end of the screw has a head F with holes drilled horizontally through it for engagement with a wrench bar. The screw head is surmounted by the cap G, which can revolve freely by virtue of the ball thrust bearing sandwiched between the two parts. Cap G is retained in its position on the screw head by a downward projecting stud with a pin engaging with circumferential groove machined therein. The upper end of the cap is hollowed to accommodate itself to the bars to be straightened.

Mounted on a retractable undercarriage with four small wooden wheels, the bar straightener can be wheeled easily up and down the lathe bed while the shaft in the lathe centers is still passing through the holes in the uprights C. The straightener is very heavy when made for thick section shafts and it is so arranged for easy movement along the work.

Procedure for straightening a shaft is as follows: The shaft is placed between the lathe centers with the bar straightener in place on the lathe bed. When rotating the shaft to find the high spot of the bend, the wheeled undercarriage is in the down position, as illustrated in Fig. 1. Lowering the undercarriage raises the straightener to the position shown so that the bar can be revolved.

High spot of the bend is marked and the straightener is wheeled into position with its jack screw under the mark. The mark should actually be in contact with the top cap of the screw. The undercarriage is then retracted as shown in Fig. 2 so that the uprights C are hanging on the shaft. The wheels are still resting on the lathe bed, but they are not supporting any weight.

By turning the jacking screw with a bar inserted into the holes in the screw head, strong bending pressure can be brought to bear on the high spot of the bend. By sliding the uprights C closer to the central nut, the straightening effect of the jacking screw can be concentrated over a shorter shaft length.

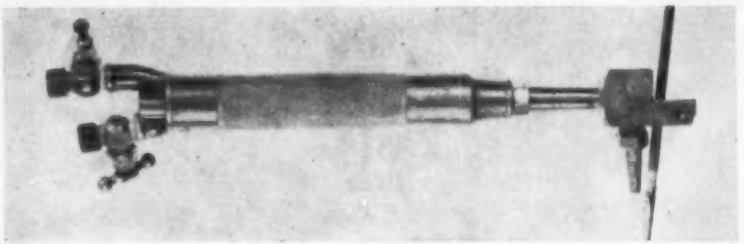
After exerting pressure with the screw, the shaft must be tested again for straightness. The screw pressure is backed off and the lever for bringing the undercarriage into action is moved to bring the straightener back to the position shown in Fig. 1. As the position of the bend on the shaft may have shifted, the straightener can be wheeled easily to the new position and applied to the shaft, as already explained.

Hot Knife Torch For Cutting Aluminum

THIS EQUIPMENT cuts aluminum plate as easily as cutting bread with a sharp knife, and does away with shearing, punching and clipping. Two flame tips are used for plate over ½-in. thick.

The equipment consists of a standard oxyacetylene welding torch with a special tip and a device which holds a tungsten knife blade at right angles to the torch. The tip permits one or more flames to impinge on the knife blade. The same or another flame acts as a preheat flame on the surface of the aluminum plate. Almost immediately after the torch is lit, the blade reaches white heat, and the preheat flame heats the aluminum almost to melting point.

The device was worked out at Boston Naval Shipyard, and reported in the Bureau of Ships *Journal*.



fold along this line—outside edges toward you

Getting Rid of Vibration in Boring Bars

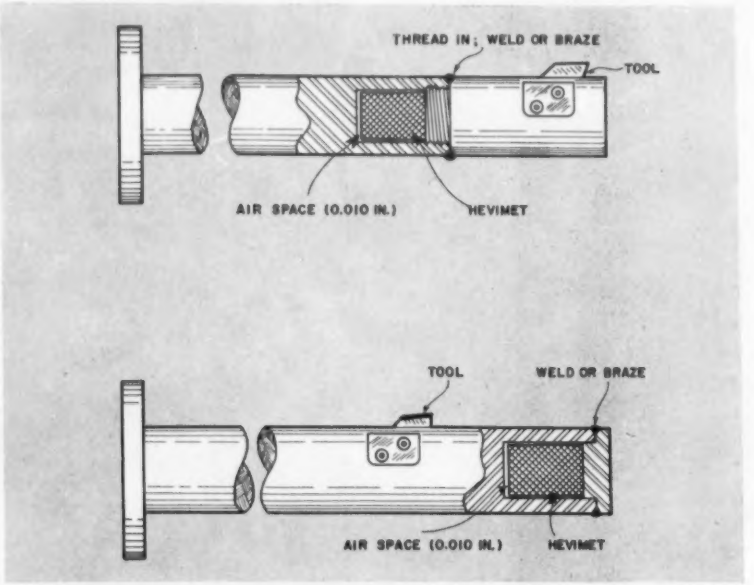
SELF-INDUCED VIBRATION and chatter in boring bars can be controlled, say Carboloy engineers, by use of damping weights built into the bars. These dampers may be made of tungsten carbide or "Hevimet" — a high-tungsten alloy twice as heavy as lead.

Construction of a self-damping boring bar is simple and can be done in several ways; two methods that work well are shown in the accompanying illustration. In all cases, however, it is advisable to locate the damping weight as near to the end of the bar as possible. The damper should also be as large as the bar will take; for instance, use a ¾-in. diameter weight in a 1-in. bar.

Air space must be provided between the bored-out cavity in the bar and the damping weight to permit it to "float." Grind the inside diameter of the hole 0.003-in. larger than the outside diameter of the damper — which should also be ground to a good surface finish. Allow 0.010-in. air space (after assembly) between the end of the weight and bottom of hole.

Ratio of the diameter of the weight to its length should be 1:2; that is, the length of the weight should be twice its diameter. For example, if the diameter of the weight is ¾ in., then its length should be 1½ in.

Both of the methods of applying damping weights to boring bars shown in the illustration work as well on rotating bars as they do on stationary bars and rotating work pieces.



Two methods of installing tungsten carbide or "Hevimet" dampers in boring bars to reduce vibration

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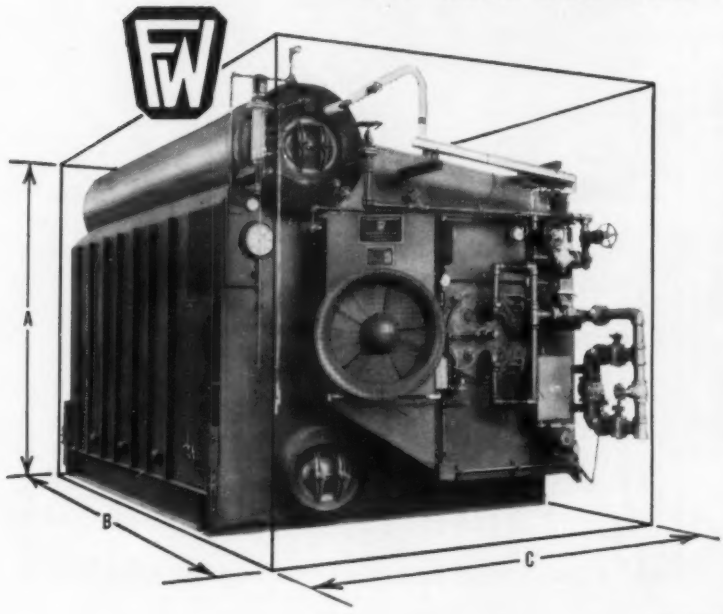
. . . with the new Foster Wheeler



PACKAGED STEAM GENERATOR

CAPACITY RANGE AND DIMENSIONS

CAPACITY lb/hr Based on 100 psi, 212F Feedwater and Zero Blowdown		A	B*	C
#6 OIL FIRED	NAT. GAS FIRED			
13,400	12,900	12′ 1¼″	14′ 6¾″	10′ 11¼″
15,600	15,000	12′ 1¼″	15′ 7½″	10′ 11¼″
17,800	17,100	12′ 1¼″	16′ 8¼″	10′ 11¼″
20,000	19,200	12′ 1¼″	17′ 9″	10′ 11¼″
21,800	20,700	12′ 1¼″	18′ 9¾″	10′ 11¼″
24,000	22,800	12′ 1¼″	19′ 10½″	10′ 11¼″
26,200	24,900	12′ 1¼″	20′ 11¼″	10′ 11¼″
28,400	27,000	12′ 1¼″	22′ 0″	10′ 11¼″
30,600	29,100	12′ 1¼″	23′ 0¾″	10′ 11¼″
32,800	31,200	12′ 1¼″	24′ 1½″	10′ 11¼″
35,000	33,300	12′ 1¼″	25′ 2¼″	10′ 11¼″
37,200	35,400	12′ 1¼″	26′ 3″	10′ 11¼″
39,400	37,500	12′ 1¼″	27′ 3¾″	10′ 11¼″
41,600	39,600	12′ 1¼″	28′ 4½″	10′ 11¼″
43,800	41,700	12′ 1¼″	29′ 5¼″	10′ 11¼″
46,000	43,800	12′ 1¼″	30′ 6″	10′ 11¼″

**Varies with method of firing and type of combustion controls. Figures listed provide safe approximation over firing and forced draft equipment.*

HERE's a *complete line* of packaged steam generating units that are built to power boiler standards . . . designed and constructed to offer these important savings.

You *save time* because they are shipped completely assembled, all ready to set on a simple foundation and connect to your fuel, steam and electric power lines.

You *save space* because all packaged units are extremely compact — designed for shipment on standard railroad flat cars. They provide high output in lowest possible installation space consistent with safe rates of heat liberation.

You *save money* because all units are shop fabricated from standard parts, simple to install, and designed for sustained high efficiency and exceptional ease of inspection and servicing.

Construction features include: 36″ steam drum and 24″ water drum — staggered boiler tubes — closely spaced waterwall tubes — effective circulation — light, highly efficient refractory and insulation — wide choice of burners and controls — baffled steam collector.

In addition to the standard units listed here, FW Packaged Steam Generators are also available for design pressures to 1300 psi, with superheaters giving up to 825 F final steam. FW extended surface economizers provide maximum efficiency at these higher pressures and temperatures. For complete information send for Bulletin No. PG-55-3. *Foster Wheeler Corporation, 165 Broadway, New York 6, N. Y.*

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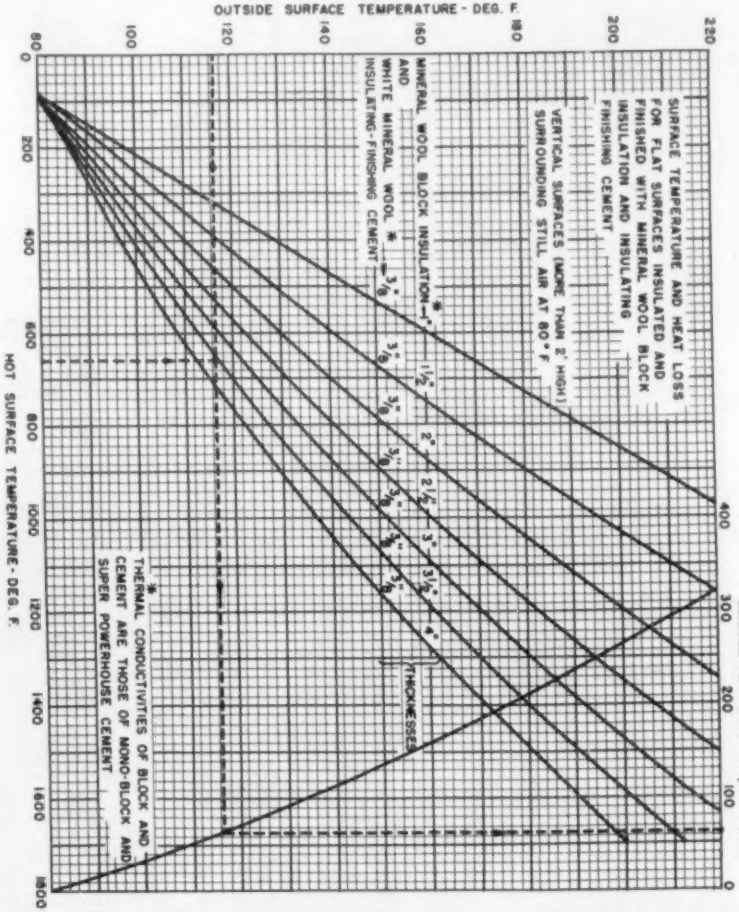
New Graph Gives Surface Temperatures, Heat Losses for Block-and-Cement


OUTSIDE SURFACE TEMPERATURE - DEG. F.
HOT SURFACE TEMPERATURE - DEG. F.
SURFACE HEAT LOSS - BTU/SQ.FT/HR.
SURFACE TEMPERATURE AND HEAT LOSS FOR FLAT SURFACES INSULATED AND FINISHED WITH MINERAL WOOL BLOCK INSULATION AND INSULATING FINISHING CEMENT
VERTICAL SURFACES (MORE THAN 2' HIGH) SURROUNDING STILL AIR AT 80° F
MINERAL WOOL BLOCK INSULATION* AND WHITE MINERAL WOOL * INSULATING-FINISHING CEMENT
THICKNESSES
* THERMAL CONDUCTIVITIES OF BLOCK AND CEMENT ARE THOSE OF MONO-BLOCK AND SUPER POWERHOUSE CEMENT

Use this chart to determine thickness-temperature requirements for mineral wool block insulation and insulating finishing cement, used for ductwork, hoppers, fan housings and other power plant equipment

POWER ENGINEERING HANDBOOK

THIS HEAT-LOSS graph has been developed by the Baldwin-Hill Co. to eliminate the laborious repetitive calculations in determining outside surface temperature (deg F) and surface heat loss (Btu per sq ft per hr) for various thicknesses of white mineral wool insulating-finishing cement. Standard thicknesses of block insulation from one to four inches are given. The graph covers hot-surface temperatures up to 1700 F and outside surface temperatures as high as 220 F.

In using the graph to determine the insulation thickness required on a 660 F preheated air duct, for example, a vertical line drawn up from 660 F on the hot-surface temperature scale at the bottom intersects the block thickness line for 3½ in., as shown. A horizontal line from this intersection to the left-hand scale shows that for these conditions, the outside surface temperature will be about 116.5 F.

A vertical line from the intersection of the horizontal line with the curve at right meets the surface heat loss scale at top right at 62 Btu per sq ft per hr, the heat loss which may be expected from the insulated air duct.

The graph also shows that with a surface temperature of 130 F or a heat loss of 100 Btu per sq ft per hr, the thickness of the block may be reduced to 2½ in.

fold along this line—outside edges toward you

Use That Old Locomotive Compressor!

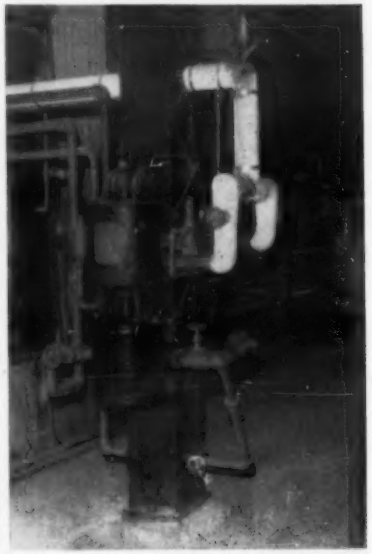
RECENTLY we carried an article describing how a locomotive compressor was utilized for emergency instrument and control air in a power plant. Now comes the news, from POWER ENGINEERING reader L. Rene Duval of Ciudad Trujillo, in the Dominican Republic, that he made the same kind of an installation in the cement factory power plant, where he is chief engineer, to operate tube cleaners.

The photograph shows how Duval mounted the Westinghouse Air Brake compressors from an old mountain-type locomotive, one on each side of a building column. Duval got a storage tank, and made an air cooler out of piping. He connected the suction side of the pumps to the 40-psi factory air line (supplied by four big compressors) and the discharge through the cooler to the tank.

One compressor easily takes care of the air supply needed for one tube cleaner. The precompressed air has had most of the atmospheric moisture already removed and gives the pumps less work to do. The compressors had their own pressure controls, which maintain 96 psi in the storage tank, with only a two lb difference either way, whether the tube cleaner is working or not.

Before installing the compressors the tubes were never really cleaned, Duval says, and down time was excessive because the 40 psi factory air pressure was too low to operate the tube cleaners properly. Now the tubes are cleaned down to the metal, and down time has been reduced by two-thirds.

Duval got his compressors from locomotives that were being scrapped by a road that had been leveled down to normal grade.



Air brake compressors from old locomotive make compressor for boiler tube cleaner air supply

POWER ENGINEERING HANDBOOK

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SURGEABILITY...

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Surgeability is defined as stability of performance under rapidly changing and unpredictable conditions including flow. This characteristic is vitally important in clarification and cold process softening installations. Surgeability is designed and built into the Graver Reactivator®.

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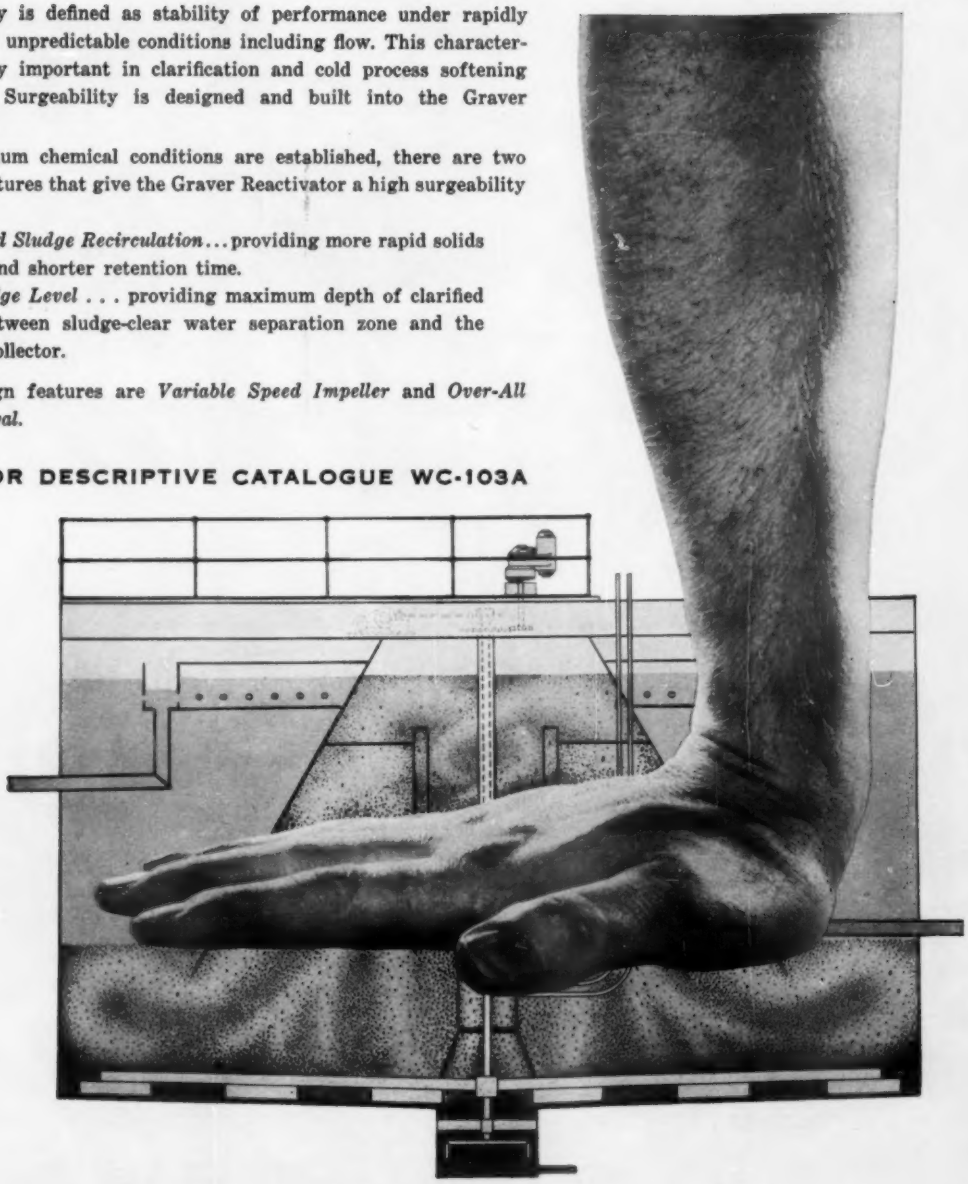

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BOILERS, GENERATORS

201 **Packaged Boilers** — This 16-pp illustrated catalog describes manufacturer's new Type VP package boiler. Following a section of background information is an outline of the principal design features of these boilers, which are shop assembled and provide steam capacities from 4000 to 40,000 lb per hour. Space requirements are shown in a table along with boiler specifications. Combustion Engineering, Inc.

202 **Steam Generators** — Illustrated Bulletin SB43, 20 pp, describes company's VL factory assembled generators combining 2-drum water-type boiler, integral water cooled furnace, brick work, insulation and steel casing. A large cutaway illustration shows design details, and gas travel. Erie City Iron Works.

203 **Improved Steam Generator** — Bulletin 2000, 28 pp, explains advance design features that distinguish this manufacturer's generator from other unit steam generators. Describes and illustrates engineering differences of component features. Also shows how these components are constructed, assembled and tested. Another section gives data, and dimensions for the units which range from 20 to 6000 hp. Preferred Utilities Mfg. Corp.

204 **Steam Generators** — Bulletin 55-1, 22-pp, describes company's products and services, including not only steam generators but also custom metal fabrication. There are many photos of boilers in various stages of assembly. Engineering drawings of boilers producing up to 500,000 lb of steam per hr on standard fuels are included, as well as illustrations of units for waste heat application and those designed to utilize refuse for fuels — wood chips, coffee grounds. The Wickes Boiler Co.

205 **Automatic Boilers** — Bulletin BE-4 describes operation and advantages of Continental automatic boiler's spinning gas technique — a method of obtaining maximum heat transfer with a simplified design. Shows cutaway view of boiler construction; illustrates hinged doors and method of injecting air through static, turbine-like vanes into burner. Boiler Engineering & Supply Co., Inc.

206 **Standard Boilers** — Eight-pp Bulletin WT-8 describes company's "S" series of boilers with capacities ranging from 10,800 to 50,000 lb. Lists data and specifications on each of the models and sizes, and discusses general design features and special "S" type construction features. Wm. Bros. Boiler & Mfg. Co.

207 **Standard Generators** — Bulletin B-55-4 describes company's SC economy series of standard steam generators designed to reduce steam costs for industrial plants. Pre-engineered, standardized steam generators offered in nine sizes,

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with capacities of from 50,000 to 150,000 lb per hour are described, and schematic and cutaway drawings of the units and design features are included. Foster Wheeler Corp.

208 Water Tube Boilers — This 12-pp catalog describes packaged water tube boilers, in capacities from 8000 to 50,000 lb per hour. Interesting as well as informative, this booklet uses color and illustrations to amplify text. Gives complete data and dimensions for boilers designed for firing oil or gas or both. Superior Combustion Industries, Inc.

209 Packaged Generators — Bulletin MH 3–54, 14-pp, gives detailed coverage to company's Type MH packaged water tube steam generators which are furnished for oil or gas firing or both, with automatic, semi-automatic, or manual controls. Included are: cutaway illustrations, installation photos, tube arrangement layouts, construction details, auxiliary equipment, dimensions. Union Iron Works.

210 Shop Assembled Boiler — Sixteen-pp Bulletin G-76 completely describes and illustrates company's Type FM water-tube integral-furnace boiler, made in standard sizes from 2900 to 28,000 lb of steam per hr, pressure to 250 psi. The Babcock & Wilcox Co.

PUMPS, COMPRESSORS

211 Controlled Volume Pumps — Bulletin 953, 24-pp, describes and illustrates use of controlled volume pumps in industrial water treating systems. Construction and operation features are described, capacity-pressure ranges and speed and stroke length adjustments are charted. Typical chemical feed and water treating systems are presented through text and diagrams; and an analysis of boiler water treating systems, cooling water treating problems, and systems for waste and sanitary water treatment included. Milton Roy Co.

212 Steam Pump Care — Bulletin G-2280, "How to Install and Take Care of Steam Pumps," is a 24-pp booklet containing a step-by-step series of 88 illustrations showing how to increase the service life of all types of steam pumps. It offers 28 tips on proper installation of the pumps, 54 tips on care techniques. Section on installation provides information on suction, packing the pump, starting it, and trouble shooting. Section on maintenance deals with such subjects as steam valves, liquid piston and rod, piston packing, liners, gaskets and many others. Worthington Corp.

213 Meter that Pumps — Bulletin 300, 8 pp, describes company's improved meter that pumps — designed for precise metering and proportioning of small quantities of low viscosity fluids at low cost, over extended periods of time. Complete capacity tables and a detailed schematic are also included. Hills-McCanna Co.

FUEL BURNING EQUIPMENT

214 For Burning Refuse Fuel — This 8-pp bulletin describes refuse fuel burning equipment, including a pneumatic refuse fuel distributor which spreads refuse fuels such as bark, wood chips, and bagasse uniformly over the grate surface. Discusses construction features of various components. Riley Stoker Corp.

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Optimum Precipitator power input is maintained regardless of operating conditions. The sensing control is simple, positive, accurate—and automatically evaluates the spark "Power Value" (intensity and frequency)—not just frequency or intensity alone.

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Under short circuit, open circuit or other varying conditions, this control is completely stable and inherently trouble-free!

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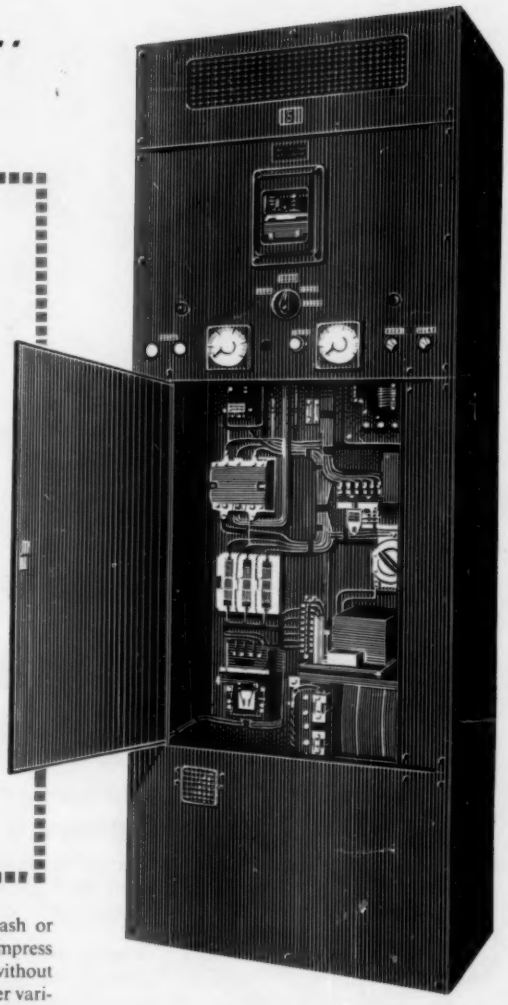
Modest initial cost coupled with negligible maintenance assure optimum operating efficiency (therefore lower operating costs) throughout many years of continuous service.



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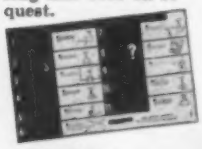

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215 Automatic Burner — Bulletin 420 contains approximately 30 pp of engineering data on a new burner unit for gas, oil or combination firing and sized for capacities to 42,000 lb of steam per hour. Separate sections of this looseleaf manual are devoted to photos and discussion of special features of the burner, general specifications, parts list, wiring and piping diagrams, explanation of operating sequence, and performance data. Available to qualified power engineers, please state your job title when requesting this bulletin. Peabody Engineering Corp.

216 Oil and Gas Burners — Bulletin OB-53, 28 pp, gives principles of selection and application of oil or gas burners, or a combination of both for standard and wide capacity range operation, together with air registers and fuel oil heating and pumping sets. Conversion table shows approximate relationships between quantity of oil burned, boiler capacity and air required for combustion. The Engineer Co.

217 Steam Atomizing Oil Burners — Sixteen-pp illustrated Bulletin 21 describes steam atomizing oil burners and auxiliary equipment for use with heavy oil or tar in boilers, stills, dryers and other furnaces where steam or compressed air is available for atomizing the oil. Includes information on furnace design and construction. National Airoil Burner Co., Inc.

VALVES, TRAPS, PIPING AND ACCESSORIES

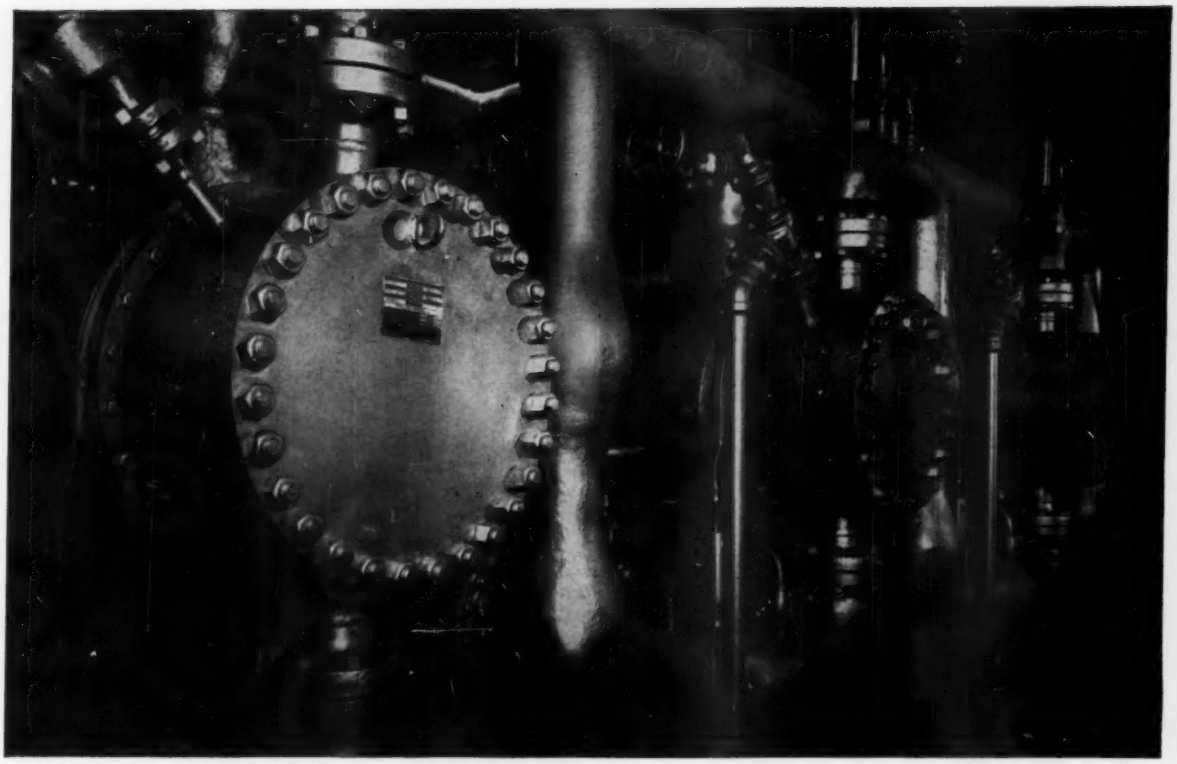
218 Check Valves — Twenty-pp Catalog 30 presents company's line of tilting-disc check valves made in iron, bronze and steel for working pressures to 3000 psi. Explains operating principles of tilting disc construction, discusses closing without slam, reduced loss of head, other advantages. Includes construction details, sizes. The Chapman Valve Mfg. Co.

219 Lubricated Plug Valves — Catalog PV-24, 36-pp, shows in detail a line of iron and steel lubricated plug valves. Many illustrations of the single, screwed and bolted gland type valves are shown, including photos, sectional and detailed drawings. Also included is physical data on dimensions. The Wm. Powell Co.

220 General Purpose Valves — Supplement No. 1 to Catalog F-9, 32-pp, offers complete information on company's series of general purpose drop forged steel valves, gate, glove and angle types, sizes ¼ through 2 in. Includes descriptions of each type along with drawings showing component parts. Dimensions and other specifications are tabulated, and a pressure-temperature ratings table is included. Henry Vogt Machine Co.

221 Valve Charts — Now available to power engineers are three well-organized wall charts on valve types, selection and protection. "How to know valves" covers four main types of valves from the standpoints of their appearance, inside construction, service intended, operation and use. "How to select valves" discusses five major factors involved in the choice of a valve — fluid, temperature, pressure, size and function. "How to protect valves" — written in "do and don't" style covers 11 important points in valve installation, operation and maintenance. R-P & C Valve Div., American Chain & Cable Co., Inc.

222 Valve Chart — Form 194, 24 pp, is a valve comparison chart, listing valve



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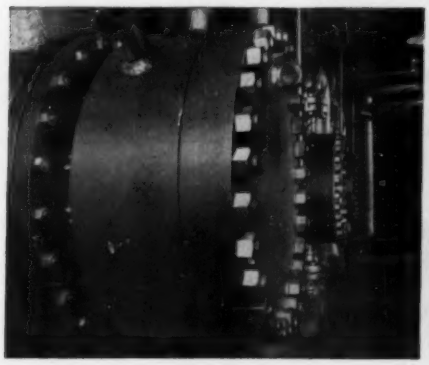

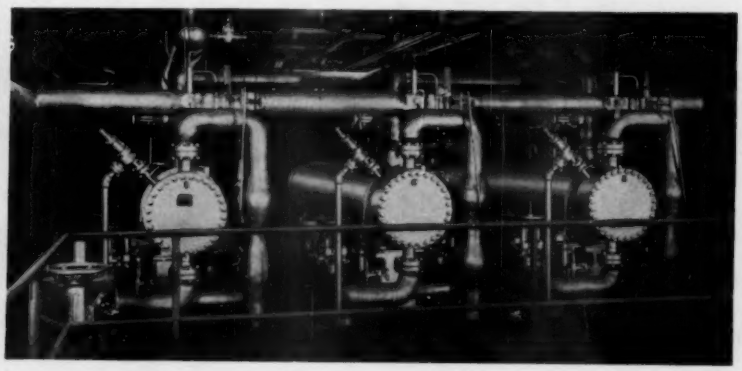

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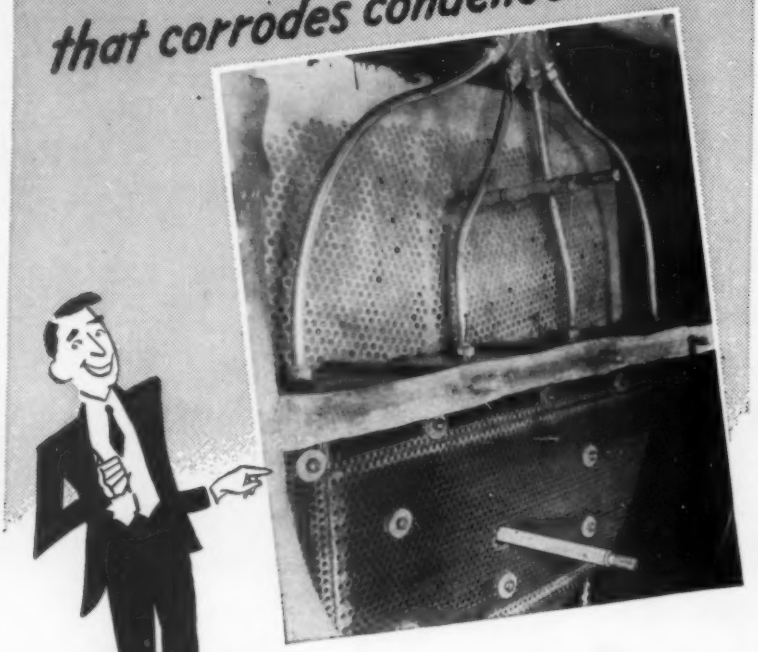

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figure numbers of 15 major manufacturers and the OIC equivalent valve figure numbers. Compares variety of valves in ferrous and non-ferrous materials, describes different valve lines. The Ohio Injector Co.

223 To Get at Those Valves — This little folder describes a sprocket rim with chain guide. The rim adjusts to fit all valve wheels. Babbitt Steam Specialty Co.

224 Regulating Valves — Bulletin 5305 describes double seated diaphragm regulating valves for use with control instruments, outlining special features of the valves, particularly the "flow line" contoured-body engineered for high capacity at low pressure drop. Leslie Co.

225 Boiler Blow Off Valves — Bulletin E-125, 24 pp, describes and illustrates the design and construction of company's quick-operating valves, angle valves, Y valves and duplex units specifically designed for boiler blow-off service. Includes dimensions. Everlasting Valve Co.

226 Water Hammer Control — Cause, effect and control of water hammer in piping systems in the subject of 8-pp Bulletin WH 851. Photos, drawings and curves supplement text, and test data is presented to show efficiency of company's silent check valves in water hammer control. Some typical installations are illustrated. The Williams Gauge Co., Inc.

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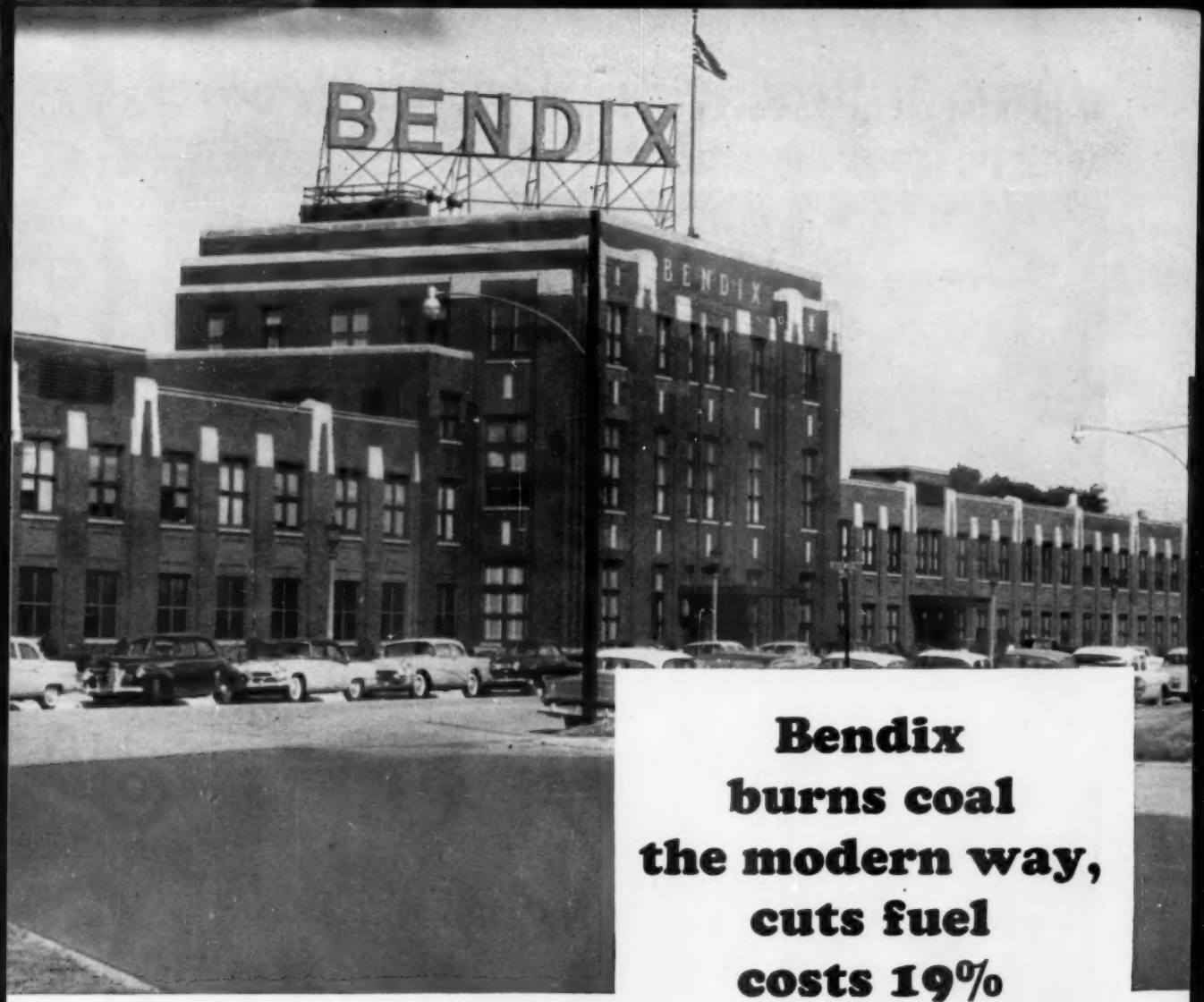
227 Pump Valves — Key features of company's line of pump valves are outlined in 6-pp Bulletin V-112. Includes cutaway view showing design features, standard materials table, and a table of standard pump valve sizes. Sims Pump Valve Co., Inc.

228 Choosing the Right Valve — Presenting valve selection as a matter of matching the valve's service characteristics with service requirements of the job, this practical 20-pp booklet explains and illustrates basic design features of gate, globe and check valves. It tells, in non-technical language, how each of these valve types works, and where it is suited for use. Disc, stem connection, bonnet and bonnet-joint characteristics are discussed and illustrated. Crane Co.

229 Steel Gate Valves — Four types of Hancock general purpose steel gate valves for process and power piping systems are described in illustrated Bulletin 202 C, 12 pp. Material specifications, dimensions given, also service pressure ratings. Manning, Maxwell & Moore, Inc.

230 Steam Trap Book — Catalog J, 44 pp, serves as a manual of trapping practice. Includes a catalog section giving physical data and prices on cast semi-steel and forged steel inverted bucket steam traps, compound steam traps and ball float air and air relief traps; a handbook section explaining how to calculate condensate loads and select traps for all classes of equipment; a maintenance section explaining trap installation, as well as



Bendix burns coal the modern way, cuts fuel costs 19%

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Designing and building hundreds of heating and power installations a year, qualified engineering firms can bring you the latest knowledge of fuel costs and equipment. If you are planning the construction of new heating or power facilities—or the remodeling of an existing installation—one of these concerns will work closely with your own engineering department to effect substantial savings not only in efficiency but in fuel economy over the years.

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At its Products Division, South Bend, Ind., Bendix Aviation Corporation undertook extensive modernization of its power system. The firm replaced two 511 HP boilers with two 80,000 lb./hr. spreader stoker fired units. A 500-ton overhead bunker and coal elevator-conveyor system were installed. Additional changes were made including an increase in the capacities of the water and air systems.

Today fuel costs at Bendix have been cut 19%, efficiency boosted from 70% to 82%, maintenance costs lowered 80% and availability upped from 50% to 96%. By burning coal the modern way, Bendix is saving many thousands of dollars yearly and will amortize the cost of modernization in a comparatively short time.

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With R/M's Big 7 Packing Types you decrease costs, increase efficiency

With R/M's Big 7 you can cut costs and downtime. You'll also reduce any chance of error through wrong selection, simplify ordering, and speed deliveries. Most plant engineers find that they can fill all of their packing needs with only 3 or 4 types.

Engineered for top performance. Type 7, R/M Vee-Flex packing, for example, is precision molded to fit practically every piston and rod, and its unique design makes it self-sealing and self-adjusting. For perfect hydraulic and pneumatic sealing to 6000 psi and above.

Your R/M distributor has complete information on the R/M Big 7 line, and he will be glad to show you how standardizing on the Big 7 will pay off in your plant. All R/M packings for maintenance purposes are sold only through authorized R/M distributors.

Type 1, for pumps, valves; **Type 2,** for high temperature valve stems, expansion joints; **Type 3,** for high speed rotary air compressors; **Type 4,** for corrosives, acids, viscous materials; **Type 5,** "Teflon"* for chemicals; **Type 6,** gasket materials; **Type 7,** for hydraulic and pneumatic equipment.

*Du Pont trademark

R/M'S BIG 7 PACKING TYPES MEET 95% OF ALL PACKING NEEDS

R/M **BIG 7 PACKINGS**
RAYBESTOS-MANHATTAN, INC.
PACKING DIVISION, PASSAIC, N.J.
MECHANICAL PACKINGS AND GASKET MATERIALS

FACTORIES: Bridgeport, Conn.; Manheim, Pa.; No. Charleston, S.C.; Passaic, N.J.; Crawfordsville, Ind.; Neenah, Wis.; Peterborough, Ontario, Canada.

RAYBESTOS-MANHATTAN, INC., Packings • Asbestos Textiles • Industrial Rubber, Engineered Plastic, and Sintered Metal Products • Abrasive and Diamond Wheels • Rubber Covered Equipment • Brake Linings • Brake Blocks • Clutch Facings • Fan Belts • Radiator Hose • Laundry Pads and Covers • Bowling Balls

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trouble-shooting and repair. Armstrong Machine Works.

231 Steam Trap Selector — Twelve-pp Bulletin T-9 is designed specifically to aid in selection and application of steam traps on chemical processing equipment. Features a foldout piping diagram for 22 pieces of typical processing equipment — each showing recommended steam trap and piping arrangements. Also contains selector tables. Yarnall-Waring Co.

232 Expansion Joints — Rubber expansion joints for relieving strains and stresses in piping, absorbing vibration, and eliminating noise are the subject of 8-pp Form AD-137. General advantages of rubber expansion joints are presented, and spool-type, U-type and rectangular-type joints are described as to construction and intended services. Also provided is catalog sheet on all-Teflon joints and Teflon-lined rubber joints. The Garlock Packing Co.

233 Flexible Ball Joint — Catalog 215-B, 20-pp, describes advantages of company's flexible ball joints for use in piping for power, process, heating, chemical, construction, or hydraulic service. Includes engineering specifications and data on the standard 300 lb series and the series 600. Screwed, flanged and welding end joints are listed, as are insulating joints and jacketed joints for handling asphalt and other liquids that solidify unless heated. Barco Mfg. Co.

LUBRICANTS

235 Turbine Lubrication — The special problems of turbine lubrication are discussed in 8-pp Bulletin TU-1. Tells how purifiers keep power units in service; discusses inhibited and uninhibited oils, company's process for reducing sludge formation within lubrication system. Illustrated with diagrams of typical installations. DeLaval Separator Co.

236 Lithium Soap Greases — This product information bulletin details qualities and specifications of company's multi-purpose lithium soap industrial greases. Advantages of multi-purpose grease use — such as prevention of lubricant misapplication, simplified maintenance procedures discussed, together with performance characteristics. Sinclair Refining Co.

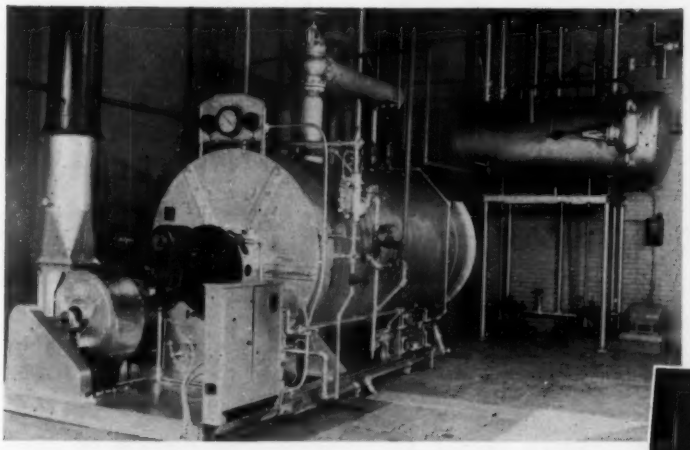
237 Versatile Industrial Oil — Described in 20-pp Form AD 4078 is an all-purpose oil offering protection for a wide range of industrial equipment, and available in 15 viscosity grades. Discusses six major characteristics of the oil; explains and pictures its use in hydraulic systems, speed reducers, air compressors, electric motors, hydraulic turbines, bearing systems, etc. A chart shows grades available, uses, properties. Standard Oil Co. (Ind.)

INSTRUMENTS AND CONTROLS

238 Metering and Control Equipment — Sixteen-pp Bulletin 18 is a comprehensive catalog offering information on company's meters, control equipment and engineering services. It is written for engineers in power plants, public utilities and process plants. Fifteen measured variables common to power and process operations form the index for selecting appropriate equipment. Bailey Meter Co.

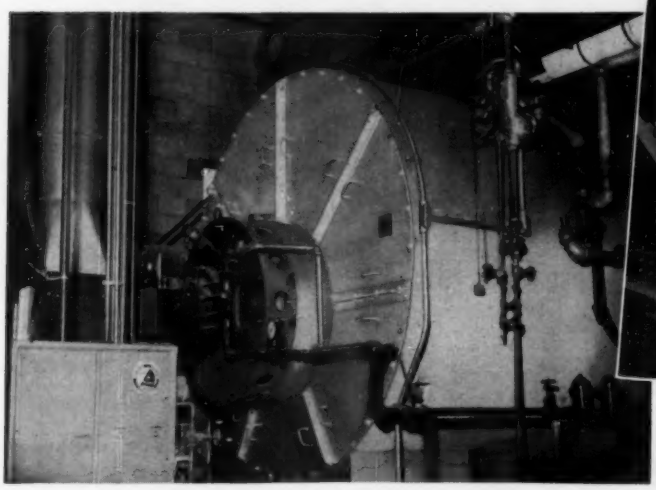
239 Boiler Feed Control — Bulletin 1003, a 12-pp catalog on boiler feed regulators, is illustrated with large application

They paid a higher initial price for eventual LOWER COSTS



The performance of this fully automatic Preferred Unit Steam Generator (150 hp, 125 psi, burning #6 fuel oil) for heating and process steam at Frank Ix & Sons, Lexington, N. C. textile mill resulted in such low operating costs that they soon ordered an identical unit. Preferred Units are doing an equally satisfactory job in another mill of the same company. "We believe we have the lowest total steam cost of any similar mill in the state. Fuel consumption is consistent with the high efficiency guarantees."

Since its first day of operation at Link Aviation, Inc., Binghamton, N. Y., this Preferred 400 hp Unit Steam Generator has consistently been saving 400 gal. of #6 oil per day over their other boiler of equal capacity.



Replacing 2 water tube boilers and 1 "package" fire tube boiler at Reichard-Coulston, Inc., Bethlehem, Pa., this Preferred 500 hp Unit Steam Generator supplies steam for heating the building and process needs at 95 psi, 24 hours a day, 360 days a year. Its thermal efficiency is over 80%; stack temperature runs between 375° and 400°F.; cleaning is required but *twice a year.* "Over comparable periods of time our records indicate lower (#6) fuel oil consumption as well as lower electrical power usage. We also find the Preferred equipment is quieter, easier and costs less to maintain and is more efficient to operate."

These are but three in the record of thousands of Preferred Units producing steam more economically for heating and process.

Compare the Preferred with any other "package" boilers or with modified boiler-burner units, and you'll see why Preferred's engineering, lower cost installation, more efficient automatic operation and low maintenance can make the difference in initial cost really pay off. Bulletin 2000 tells how.

Be sure to see our exhibit booth #98 at the Exposition of Power & Mechanical Engineering, New York Coliseum, Nov. 26-30.

PREFERRED UTILITIES MANUFACTURING CORP.

1860 BROADWAY (Department PE) NEW YORK 23, N. Y.

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You don't pay for sludge like this when you buy Morton Purex Salt

When you buy Morton Purex Salt, you get high purity evaporated salt that is made in a controlled-particle size to prevent packing and channeling. None of your freight bill or purchase price goes toward paying for shale and sulphates . . . insolubles like those shown on the filter pad above. (And the cost can be considerable. In every 100 lbs. of any type of rock salt, you are paying for up to 5 lbs. of insolubles.)

With Purex, no time or labor is spent in cleaning out insoluble matter from your brine making system to keep it functioning at peak capacity. For Purex is 100% soluble. Morton Purex will leave no accumulation of material in either brine or water softener tanks. It can be used in bulk wet-storage systems, and in the Morton Model-E Brinemaker.

For more information about Morton Purex Salt, or for free, expert help on any water-softening or brine-making problem, write or wire:

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INDUSTRIAL DIVISION
Dept. PoE-11, 120 So. La Salle Street,
Chicago 3, Illinois

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photos and detailed schematic drawings and charts. Relay and direct operation are covered. Case studies of representative boiler loads are presented to show stability of the Flowmatics in controlling feedwater. Copes-Vulcan Div., Blaw-Knox Co.

240 Instruments, Controls — Condensed Catalog 1537 offers brief application information on manufacturer's line of instruments. Fully illustrated, covers draft and pressure instruments, flow meters, liquid levels and pressure gages, CO_2 meters, pneumatic transmitters, positioning operators, temperature instruments, boiler feedwater controls, others. Includes references to detailed literature on each type of equipment. Republic Flow Meters Co.

241 Indicating Flow Meter — Bulletin 18-A, 22-pp, discusses advantages, construction and operation of company's Type H indicating flow meter. Presents technical data on the principles and theory of fluid measurement and discusses orifice type meters and orifice meter principles. Offers examples of flow rate calculations. Schematic drawings and diagrams, tabulated technical data and specifications are included. The Meriam Instrument Co.

242 D-C Amplifier — Twelve-pp Bulletin MSP 111.1 provides pictorial diagrams and descriptive information on company's PowrAmp Model P, an electronic low-voltage linear amplifier designed to increase the speed and accuracy of low level d-c voltage measurements. Discusses performance and construction features of the amplifier and describes some applications. Hagan Corp.

243 Resistance Temperature Detectors — In 8-pp Publication 3016D are described a line of remote temperature-sensitive elements for use in indicating, recording, controlling and monitoring equipment. Operation, application and construction details of the resistance temperature detectors are presented, along with specifications and ordering tips. Instrument Div., Thomas A. Edison, Inc.

244 Ideas on Push Pull Controls — Included in this "Idea File" are answers to a power engineer's questions on the use of push-pull controls. A general information booklet discusses remote control applications, explains construction and operation of company's Tru-Lay controls. Separate bulletins are devoted to standard assemblies, bracket-type head controls, micro controls and hand-operated controls. Automotive and Aircraft Div., American Chain & Cable Co., Inc.

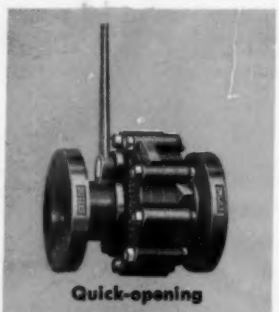
MECHANICAL POWER TRANSMISSION

245 V-S Drive Selection Tips — Bulletin 20P50, 44 pp, carries handy multi-color tables for quick and easy selection of variable speed Texrope drives. In addition to providing these tables for A, B, C and D section variable speed drives, booklet includes information on design features, drive principles, horsepower rating tables, speed range table. Allis-Chalmers Mfg. Co.

246 Fluid Drives — Bulletins 9419 and 9519 are an illustrated catalog and selection guide on company's new Type VS Class 2 Gyrol fluid drives. Catalog discusses advantages and applications of the drives, covering speed control, power savings, simplified installation, etc. A sectional view shows construction and principle of operation. Dimensions for six

Combine them

any way you choose for your boiler blow-off



Quick-opening

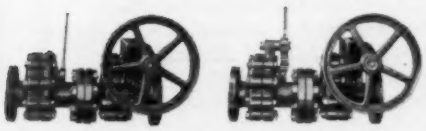
Slow-opening Angle Type

Slow-opening Y Type

Straightway and Angle Duplex Units

Straightway and Y Duplex Units

Angle and Y Duplex Units



Straightway Duplex Units

More than a dozen different arrangements of valve designs and operating methods are available to you in the complete Everlasting line of boiler blow-off valves for operating pressures up to 600 psi. Here is a range of selection from which you can get exactly the combination you wish.

For half a century, Everlasting Valve designs have been proving their effectiveness, reliability and durability—the kind of service you need for boiler blow-off. Each design fully meets ASME Code requirements. WRITE FOR BULLETIN

For "everlasting" service, use

EVERLASTING Valves

EVERLASTING VALVE CO.
47 FISK STREET, JERSEY CITY 5, N. J.

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sizes of drives are provided. Selection guide consists of tables indicating proper drive to use. American Blower Corp.

247 Speed Reducers — Design and operation advantages of company's line of Torque-Arm speed reducers are outlined in 28-pp Bulletin A-637. Includes selection tables for double and single reduction units, bore dimensions and bushings, data on overload releases, flange mounted speed reducers, and recommended V-belt drives. Dodge Mfg. Corp.

WATER CONDITIONING

248 Feedwater Treatment — Process Bulletin B1, "Treatment of Boiler Feedwater by Direct, or Internal Method," discusses advantages of direct treatment, as a complete treating program or as a supplement to external systems. Explains why direct treatment is convenient, economical and complete, and points out how it improves steam quality and reduces boiler maintenance costs and downtime. National Aluminate Corp.

249 Water Conditioning Data Book — An excellent reference volume, Data Book 2478A contains 108 pp and presents a compilation of 78 chapters and tables. Subjects covered include hydraulics; impurities in water; chemical conversions; coagulant, acid and alkali dosages; chemicals used in water treatment; water treatment processes; boiler feed make-up requirements; alkalinity relationships; specific gravities; chemical reactions. Available to qualified power engineers, please state your job title when requesting this. The Permutit Co.

250 Handbook on Demineralizing — Comprehensive 40-pp Bulletin 5800-B compares various methods of water treatment, indicating the comparison between demineralizers and evaporators. It discusses the characteristics of the various types of available cation and anion exchange materials and offers data on operating costs of demineralizing. It tells when to use 2-bed, 3-bed, 4-bed, mixed or mono-bed demineralizers. It also indicates when decarbonators or vacuum deaerators should be installed. Cochrane Corp.

251 pH and Chlorine Control — The 12th edition of company's handbook "Modern pH and Chlorine Control," 100-pp, incorporating theory and practice of colorimetric analysis, serves as a reference for quantitative determination of pH, chlorine, phosphate, nitrite, sulfate, hardness and other tests. Slide comparators and complete test kits are illustrated. In addition to standard pH determinations, methods are outlined for quantitative analyses of phosphate, calcium, magnesium, silica nitrate hardness in feedwater. Available to qualified power engineers. W. A. Taylor Co.

252—Water Treatment—Bulletin 5000, 24 pp, explains the reasons for boiler water treatment and tells services offered by company in providing formulations for individual plant requirements. Covers pretreatment, internal treatment, treatment application, blow-down adjustment, test control. Dearborn Chemical Co.

Postage-free cards for ordering catalogs are on page 114. You may also use the cards to order literature mentioned in the ads.

253 Carbon Dioxide Measurement — Technical Paper 133, 16-pp, discusses determination of CO_2 in water by conductivity measurements. Describes a new method developed for the determination of carbon dioxide which is applicable to analysis of waterside deposits, treatment chemicals and organic carbon in water. W. H. & L. D. Betz.

254 For Feedwater Analysis — Bulletin 148BP contains a technical discussion of manufacturer's analyzers for determination of dissolved oxygen and hydrogen in feedwater. Discusses both O and H units as to function, ranges, accuracy. Cambridge Instrument Co., Inc.

ELECTRICAL EQUIPMENT

255 Testing Instruments — Bulletin 19-56, 16-pp, features company's electrical testing instruments, including ohmmeters, ground testers, dielectric tests sets, motor rotation tester, cable fault locating equipment, transformer turn ratio test sets, corona test equipment, frequency meters, tachometers, others. Includes photos and descriptions of each type, including chief features, operating ranges, and applications. James G. Biddle Co.

256 Industrial Systems — Bulletin GED-3039, 48 pp, gives information on distribution system planning. Features, advantages, application, operation and other

Four Good Reasons for Specifying

GOODALL EXPANSION JOINTS

Because they are made of rubber, Goodall Expansion Joints have certain advantages stemming from rubber's natural characteristics. Among these are the following:

1—LONGER SERVICE LIFE. Continuous movement during expansion and contraction actually keeps the rubber joint "alive." There is no deterioration through embrittlement or corrosion.

2—SENSITIVE RESPONSE TO PRESSURE. Only the slightest pressure is required to create movement in the rubber joint, in any direction. Stress on metal pipe or other connected member is therefore reduced to an absolute minimum.

3—EASIER TO INSTALL . . . on new construction or as replacements for other types. Light in weight . . . short face-to-face dimensions . . . retaining rings or flanges quickly aligned and bolted. No gaskets required.

4—AVAILABLE IN "FLANG-LOK" STYLE . . . a patented Goodall development which provides exceptional ease of installation; a far greater sealing face area than the standard right-angle style; and a seal that is completely non-metallic.

Sizes 3/8" to 96", I.D., for Pressures up to 125 lbs. P.S.I. and/or Vacuum

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"If it's GOODALL, it MUST be GOOD!"

Standard of Quality—Since 1870

HOSE • BELTING • FOOTWEAR • CLOTHING AND OTHER INDUSTRIAL RUBBER PRODUCTS

GOODALL *Rubber Company*

GENERAL OFFICES, MILLS and EXPORT DIVISION, TRENTON, N. J.

Branches and Distributors Throughout the United States and in Canada

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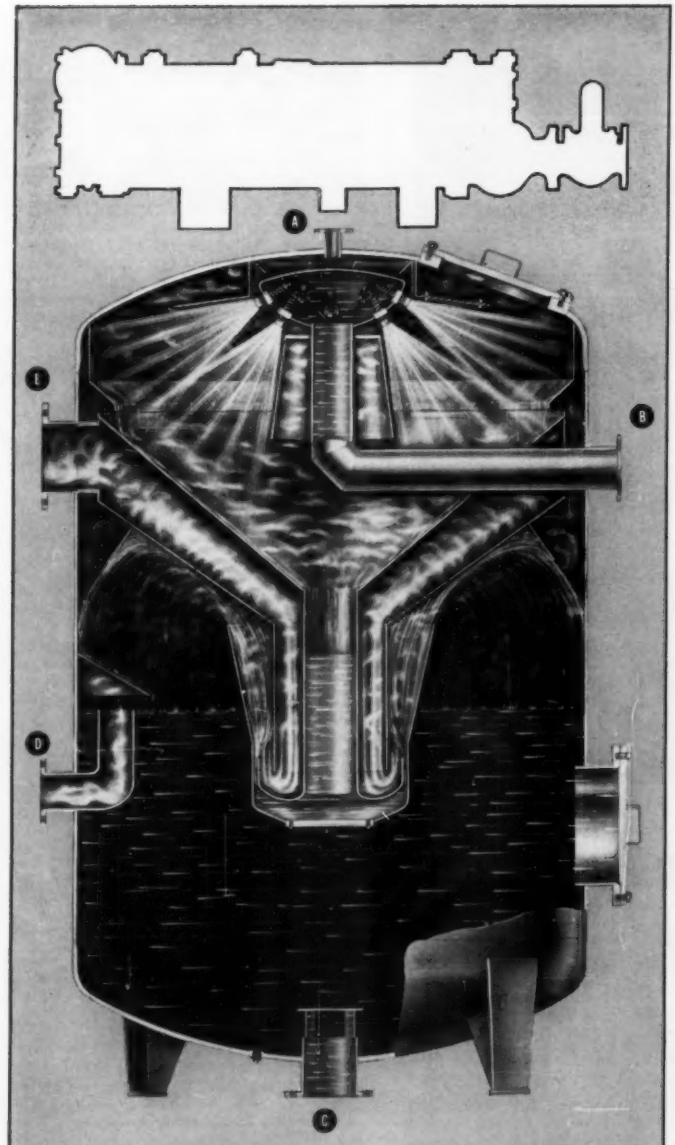

Full-contact deaerator needs no external vent condenser (white outline). The full-contact design effectively concentrates the vent-mixture inside the deaerator shell.

A Vent to atmosphere
B Water inlet
C Pump suction connection
D Overflow connection
E Steam inlet

WORTHINGTON

Now! Do away with deaerator maintenance

Here's a modern deaerator that eliminates most service problems because it has no vent condenser.

Virtually eliminates maintenance. Crammed up against the ceiling, vent condensers are difficult to inspect and clean. With a Worthington full-contact deaerator you eliminate this trouble and expense. For plants that normally operate around the clock, shutdown for deaerator maintenance is rarely necessary.

The carefully proportioned displacement flow path provided in the full-contact design concentrates the vent mixture by direct contact inside the deaerator shell. The vent condenser is no longer necessary.

Saves space. Headroom required by the deaerator may be cut by several feet—an important consideration in today's modern power plants where space is at a premium.

High efficiency. Like all Worthington deaerators, the full-contact unit is highly efficient at light as well as full load, as confirmed by numerous field tests.

Full-contact deaerators in various shell arrangements are available in capacities from 2,000 to 3,000,000 pounds per hour. Bulletin W-210-B32 has complete details. Incidentally, for the small power plant, Worthington builds a line of low-headroom deaerators that eliminate expensive elevated construction. For details, write to Section S66, Worthington Corporation, Steam Power Dept., Harrison, N. J. In Canada: Worthington (Canada) 1955, Ltd., Toronto, Ont. S-66

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LITHIUM CORPORATION PLANT AT BESSEMER CITY, N. C.

Industry's blistering pace demands...

ALL-OUT BOILER PERFORMANCE LIKE LITHIUM CORP. IS GETTING

Lithium, the "Horatio Alger" metal, is making an impact on every segment of industry... and Lithium Corp. of America's plant at Bessemer City, N.C. is meeting the mushrooming demand by peak load refining. This processing requires high pressure steam for vacuum jet equipment, a load of 60,000 lbs. per hr. at 140 psi. on the two Bros Packaged Boilers.

This peak load boiler performance is important, of course. Another big point in the Lithium plant boiler room is nominal maintenance; water tube inspection of these Bros boilers after 15 months of near-capacity operation showed *no scale formation.*

That's the kind of performance that makes a real hit with boiler engineers; yet Bros-engineered flexibility and economy pay off in the front office, too. Here's why:

Complete factory-assembled units. Bros Packaged Boilers are self-contained units, easy to transport and easily installed at low cost. They go on-the-line with simple service connections... no time or money wasted on slow, costly erections at the plant. These boilers quickly respond to varying loads; they supply steam requirements often expected only of larger, more expensive boiler equipment.

Capacities range from 4,000 lbs. steam per hour and up. Whatever your steam needs, Bros has the precise Packaged Boiler for the job. These units burn oil, gas, or both. Equipped with fully automatic, semi-automatic or manual controls.

WRITE TODAY for your free copy of the Bros Packaged Boiler brochure.

BROS

WM. BROS BOILER & MFG. CO.
POWER DIVISION
1057 Tenth Ave. S. E.
Minneapolis 14, Minnesota

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data on system-engineered equipment for industrial power distribution, including switchgear, unit substations, switchboards, transformers, busways, wire and cable, conduit products, voltage regulators, capacitors, circuit breakers, safety switches, panelboards, controls, motor controls, motors, turbines, rectifiers, and wiring devices are covered. General Electric Co.

257 On Copper Conductors — Publication C-25, 62 pp, is designed to help make the selection of bus conductors easier. Included in booklet are tables regarding such shapes as channels, ventilated square tubes and round tubes. There are tables for other rigid bus conductor shapes, also data on bare copper wire and cable as well as commonly used alloy wires. Also provided is a general discussion of copper, its physical and electrical properties. Photos illustrate many installations. The American Brass Co.

258 High Capacity Fuses — Form HCS, 6 pp, describes fuses of unlimited interrupting capacity on voltages to 600, designed to afford protection for loads of 600 to 5000 amp. Includes test data, charts on opening time, current limiting effect. Bussmann Mfg. Co.

259 Fuses for All Uses — This revised edition of manufacturer's Complete Line Folder 3 includes illustrations and descriptions of fuses for every purpose. Features dual-element cartridge fuses for time-lag in protection against overloads, and delay renewable fuses and renewal links. Economy Fuse & Mfg. Co.

260 High-Power Batteries — Bulletin CP-538 55 covers company's line of Hi-Power batteries for use in the control, switchgear, emergency lighting and auxiliary power fields. Includes data on battery ratings and capacities, details of design and construction, dimensions, weights and types of containers. C & D Batteries, Inc.

PACKINGS, SEALS

261 Mechanical Seals — Bulletin 8-205-2, 8-pp, covers the complete line of chemically inert mechanical seals for handling all types acids, corrosives, solvents and gases. Provides construction, service and application information, installations and engineering details. Crane Packing Co.

262 Packings and Gaskets — Catalog P-100C, 32 pp, covers 95 most popular packings and gaskets in company's line, furnishing details of construction, service recommendations and size information. Includes charts showing applications. Packing Div., Raybestos-Manhattan, Inc.

REFRACTORIES, INSULATIONS

263 Insulations, Refractories — This 20-pp catalog features thermal insulations and refractories for general industrial applications. Organized for quick reference, catalog provides information on composition, physical and thermal properties and sizes of the various products. Lists chief advantages, covers materials for efficient control of temperatures from −400 F to 3000 F. Johns-Manville.

264 Refractory Concrete — Basic information on recommended practice for mixing and placing refractory concrete, used in the metal, power, ceramic, and petroleum refining industry as a material to withstand service temp to 2600 F or more, is presented in this 16-pp manual.

STICKLE *Open Float*
STEAM TRAPS
FOR EVERY TYPE SERVICE

No Levers! No Toggles!
No Hinges! No Diaphragms!

There's a Stickle open float steam trap for every service . . . for every pressure and vacuum. Capacity range: 500 to 46,000 lbs. per hr. Simple, positive operation automatically regrinds valve and valve seat. Air and gases discharge with condensate. Many still operating after 44 years of continuous service.

SERIES 100 TRAPS (Shown Above)
For drainage of smaller processing units operating at low, medium or high pressures. Internal strainer. Capacity range: 500 to 3,000 lbs. per hr. For straight-in-line installation. Write for Bulletin 115.

SERIES AE TRAPS
For drainage of larger units operating at medium and high pressures. Capacity range: 5,000 to 20,000 lbs. per hr. Write for Bulletin 315.

SERIES 50 TRAPS
For drainage of units operating at medium and high pressures. Capacity range: 18,000 to 46,000 lbs. per hr. Write for Bulletin 515.

STICKLE STEAM SPECIALTIES CO.
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Specialists in Reducing the Cost of Steam—Since 1905

Stickle Equipment
Cuts the cost of steam

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Sections are devoted to special properties of refractory concrete, aggregates, refractory insulating concrete, and structural design. Universal Atlas Cement Co.

265 Refractory Cement — Heavy duty brick bonding and patching mortar is described in this 8-p illustrated color folder. Includes success stories concerning the product's application in high temperature work and in the protection of equipment against slag, fly ash and gases. Refractory and Insulation Corp.

TUBING AND ACCESSORIES

266 Rotary Tube Cleaners — Bulletin R-105 presents air and water driven rotary tube cleaners and cleaner accessories. Illustrates several models and heads. Roto Div., Elliott Co.

267 Life Extension for Condenser Tubes — The 32-pp current edition of this booklet reports on research into the causes of corrosion and means of combating them, as well as the choice of condenser tube materials. Points out that Admiralty metal, long a standard for power plant condenser tubes, works satisfactorily in most installations, but other alloys may be necessary in some circumstances. Revere Copper and Brass, Inc.

268 Tube Tools — Eight-pp Bulletin 58 describes advantages and application of company's line of tube cleaners, tube expanders and maintenance tools, including drills, brushes, accessory and specialty tools. Photos are included as well as size and selection data. Airetool Mfg. Co.

269 Heat Exchanger Tubing— Cited in this 30-pp catalog are typical cases where cupro-nickel or Monel tubing installed in heat exchangers resulted in substantial savings and better efficiency through longer tube life. Describes applications of this tubing in various instances where unusual water conditions, as to pollution, excessive turbulence, temperature and the like, required tubing that would withstand this rigorous wear. The International Nickel Co., Inc.

COAL, ASH HANDLING

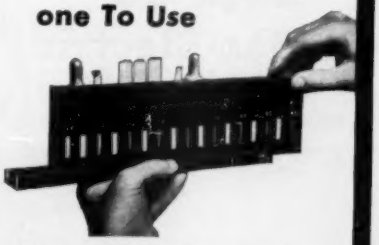
270 Tractor Shovel — The engineering, design and production stores of company's HD-11G tractor shovel are pictorially presented in 8-pp Catalog MS-460. Includes specifications and describes various features which mean easier servicing for less time-down and greater operator comfort. Allis-Chalmers Mfg. Co.

271 Spreader Stoker — Sixteen-pp Bulletin 800 describes manufacturer's Type C-C RotoStoker, a relatively small spreader stoker offering continuous cleaning and ash discharge advantages of larger units, without need of a basement for ash-removal. Explains this and other operational advantages of the stoker, which is adapted to modern steam boilers with output capacities to 75,000 lb of steam per hour. Detroit Stoker Co.

272 Improved Crushers — Bulletin 12-C, 16-pp, describes company's line of crushers for reducing coal, coke, glass cullet, gypsum, lime, metal turning, sugar, sulphur and similar lump materials. Covers Knittel ring type crushers, two-stage double-roll crushers, single-roll crushers, and double-roll crushers. Photos, dimensional drawings and full specifications are included. Stephens-Adamson Mfg. Co.

TAYLOR COMPARATORS
give
QUICK, ACCURATE
pH, PHOSPHATE TESTS

Complete, Compact Kit—Easy for Anyone To Use



Exact determinations of pH or phosphate content can be made in a matter of minutes with Taylor Comparators. Easy-to-use Taylor Comparators require no additional equipment or chemicals. Everything necessary to make tests comes with each comparator. Compact carrying case also available. No experience or technical knowledge needed. Just fill the middle test tube with the treated sample, move color standard slide across until colors match and read value direct from slide. *Complete water analysis is only a little more detailed with the Taylor Water Analyzer.*

Also, you can determine water hardness quickly, yet with the ease and accuracy of an alkalinity titration, when you use the Taylor Total Hardness Set.

COLOR STANDARDS GUARANTEED

Taylor liquid color standards carry an unlimited guarantee against fading. There's never any danger of mechanical inaccuracy. Each complete set of standards is mounted in a lightweight, plastic slide . . . eliminates the need for handling fragile, single standards.

SEE YOUR DEALER for Taylor sets, or write direct for FREE HANDBOOK, "Modern pH and Chlorine Control". Gives theory and application of pH control. Also illustrates and describes complete Taylor line.

W. A. TAYLOR AND CO.
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"Lights Off"— as simple as this!

The Peabody Type SL Gas-Electric Ignitor...

... for fuel burners provides quick, positive and stable ignition for all firing conditions. The simple turning of one handle accomplishes the full operating sequence to establish the ignitor flame.

This ignitor does not employ long electrodes or insulators. All electrical components and adjustable elements are located *outside* the burner windbox; only the flame tube passes through it. All working parts are always readily accessible even when the ignitor is used with a pressurized furnace. This rugged packaged unit, of attractive modern design, is built of the finest materials to give long life with minimum maintenance.

It fills the needs for a dependable, positive and safe ignitor for all types of fuel burners, and is available for manual operation, as illustrated, or with motor drive for remote control. For detailed information, write direct or call your nearest Peabody representative.

PEABODY ENGINEERING CORPORATION

232 MADISON AVENUE, NEW YORK 16, N. Y.

OFFICES IN PRINCIPAL CITIES

PEABODY LIMITED • LONDON, S.W. 1, ENGLAND

6-240

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273 **Cola Crusher** — Company's WC and WS series rolling ring coal crushers are described in Bulletin 154. Emphasizes special construction elements that mean greater coal reduction at lower operating costs. Cross section illustration shows both feeding and crushing action incorporated and tables give capacities, speeds, and dimensions. American Pulverizer Co.

274 **Why Liquid Diffusion** — What liquid diffusion can do for power plants is explained in Form B, which tells how liquid diffusion compounds work and gives four practical applications. These include dust control in coal handling, fly-ash control, coal storage pile treatment and boiler cleaning. Johnson-March Corp.

OTHER EQUIPMENT

276 **Petroleum Pitch** — This illustrated article on petroleum pitch as a boiler fuel stresses its low cost, other advantages. Explains combustion of pitch; discusses unloading method, burning, storage, fuel oil treatment, also precautions in handling hot pitch. Kor Corp.

277 **Steam Condensers** — Features and applications of company's line of steam condensers are detailed in this 24-pp illustrated bulletin. An engineering section offers formulas for determination of heat transfer rates, pressure drop, and other factors that apply specifically to the class of heat exchanger in which steam at high vacuum is condensed by cold water flowing through tubes. Air removal equipment, maintenance, steam condenser specialties are other subjects covered. Condenser Service & Engineering Co., Inc.

278 **Preheating Combustion Air** — This well-illustrated 36-pp booklet explains fuel savings and increased performance made possible by using waste heat in flue gases to preheat incoming combustion air. Also covers increased boiler output, ability to use lower grade fuels, other advantages afforded. Booklet contrasts regenerative with recuperative preheaters; explains operating principle and structural details of the Ljungstrom air preheater. Applications for other than power boilers are also covered. Air Preheater Corp.

279 **Product Guide** — Manufacturing facilities for company's line of steam turbines, turbine generators, ship propulsion units, feed pumps, centrifugal compressors, blowers, centrifugal pumps, reduction gear, and other products are described in this profusely illustrated 50-pp catalog. Photos show manufacturing procedure. De Laval Steam Turbine Co.

280 **Steam Turbines** — The advantages of company's solid wheel turbines, axial flow turbines, single stage and multistage, are outlined in illustrated Bulletin S-140. Describes various models in their line and includes application photos. The Terry Steam Turbine Co.

281 **Conveyor Belt Chart** — Engineering data for standard conveyor belt constructions is given in this chart and accompanying sheet. Strength characteristics of eight popular ply and material combinations of conveyor belt constructions are provided. Each property is printed on the chart in a different color to facilitate comparison. Quaker Rubber Corp., Div., H. K. Porter Co., Inc.

282 **Corrosion, Abrasion Control** — Modern practices and products for the

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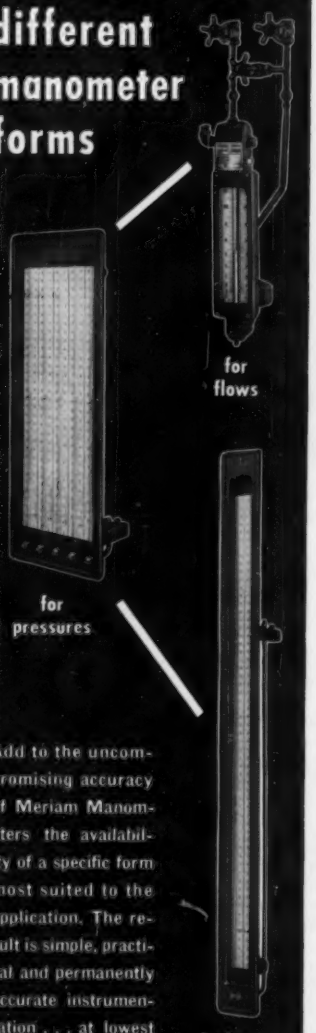

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positive protection of metal equipment from the effects of corrosion and abrasion are described in this 16-pp bulletin. Covers factory and field application of rubber or synthetic linings to metal parts or products, and maintenance coatings available for application by plant personnel. Goodall Rubber Co.

283 Turbine Speed Control — Thirty-pp wire-bound Bulletin H-21 is titled "Fundamentals of Turbine Speed Control." It is an elaborately illustrated, educational booklet intended to clarify the operation of common types of automatic speed control for steam turbines. An introductory section covers general fundamentals of automatic control systems, and includes a key to control terminology. Simplified diagrams show operating principles of actual control systems. Elliott Co.

Bulletins reviewed here are offered primarily for qualified power engineers. Manufacturers may withhold literature from persons who do not state their job title and company. Some manufacturers also prefer not to send literature to those in foreign countries in which they have no sales representatives.

284 Sectional Condenser — Bulletin 131 shows benefits of sectional-design refrigeration condensers for 100 to 240 tons refrigeration capacity and explains their functions with diagrams and installation photos. A cutaway shows component parts. Niagara Blower Co.

285 Heat Transfer Apparatus — Condensed Bulletin HT-1 highlights representative products in company's line of heat transfer equipment. Includes oil heaters and coolers, strainers, evaporators, heat exchangers, radiafin air coolers, tubes, pipes, and coils. Cross-section views of typical units are shown; brief descriptions given. Schutte and Koerting Co.

286 Technical Refrigeration — Twelve-pp Bulletin 754 covers a complete line of environmental testing and processing equipment. Provides illustrations and specifications on recently redesigned altitude, humidity, low temperature and prefabricated test chambers as well as specialized testing equipment. Includes helpful engineering data. Bowser, Inc.

287 Water Cooled Stoker — Design and operating advantages of the Vibragrate stoker are outlined in this illustrated bulletin. A large cutaway view details component parts. Other drawings show typical installations. American Engineering Co.

288 Centrifugal Dust Collector — Twelve-pp Bulletin 100 introduces the Cyclo-trell multiple tube dust collector which operates on centrifugal collection principles and incorporates new features to boost collection efficiency and gas handling capacity. An illustrated explanation of operation and construction of this collector is accompanied by collection efficiency and capacity nomographs. Tables give design data for six sizes, from three to 20 tubes. Research-Cottrell. Inc

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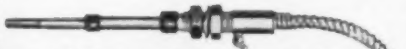

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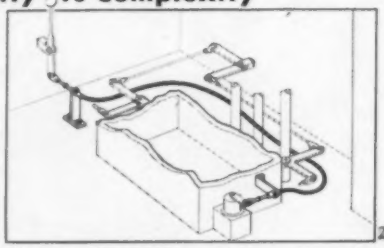

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Chrysler Corporation recently repaired the cylinder of a 3000 ton hydraulic press with this material and reported that they saved over $25,000 and 60 days of lost production time. A paper mill in Canada filled the break in the water jacket of a large air compressor and was able to resume production in three hours. It has been used successfully for repairing equipment such as centrifuges, large power plant valves, pipes, tanks, machine tools, etc. One chemical company used it to build up the inside surfaces of large centrifugal pumps that had been worn away by abrasion and corrosive liquids.

If you want more information about this material write to the Editor or use one of the prepaid post cards elsewhere in this issue. Just write PLASTIC STEEL on the card and mail it to us.

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Maintenance

continued from page 72

in order to estimate the time to be allowed for emergency work in future scheduling.

As a major by-product of records kept of emergency outages and repairs to equipment or systems, accurate determination of the histories of items will help immeasureably to determine any flaws existing in design, fabrication, installation, or operation, or to substantiate good service records. Further, such records are of importance in determining the frequency, extent, and emphasis of future inspection and maintenance activities.

In projecting maintenance schedules, the percentage of time allotted to emergency maintenance should be, for a time, gradually decreased in favor of an increased number of scheduled items. This is based on the premise that intensified scheduling will decrease the frequency of emergencies, imperceptibly at first, then more rapidly until a flattening out toward a reasonable minimum, beyond which emergency expectancy should not be decreased.

It will often be found that emergency outages may necessitate or offer a practical opportunity for an overhaul of the item involved and perhaps other items, resulting in a re-arrangement of the regular maintenance schedule. The apportioning of time to emergency and scheduled maintenance in such instances must depend upon the individual circumstances involved, such as whether the emergency necessitated an immediate overhaul, or merely made re-arrangement of the schedule convenient.

For example, take the case of a boiler forced into a prolonged outage by the failure of an economizer header which required some time for delivery; if that boiler had been scheduled for major overhaul within the next several months it might well be advantageous to perform many or all of the major overhaul functions during the emergency outage. However, this change would consist of merely a re-arrangement of the maintenance schedule, and all the work done would not be chargeable to the emergency outage, but merely that portion of the work required to eliminate the cause of the outage. The balance would, of course, be charged to scheduled maintenance in the normal manner.

On the other hand, if the boiler forced out of service were not scheduled for major overhaul within a period which would make re-scheduling practical, it is probable that all work on the boiler during the outage, whether or not directly concerned with the cause of the outage, would be charged to emergency maintenance. The same would be true if re-scheduling of the boiler were impossible because of a coinciding

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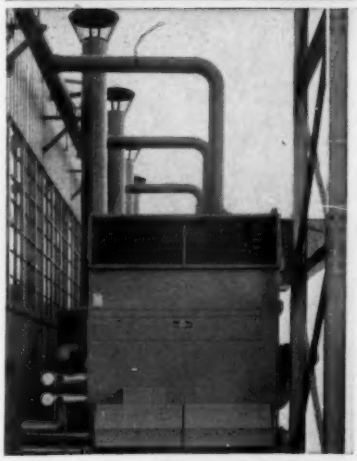

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continued from page 131

major overhaul in progress, such as that of another boiler.

New Construction

New construction work done by the maintenance department under Construction Work Orders is a necessary part of the department's work, for it is often the only source available for the early economical completion of the job. To some extent, it is work which cannot be scheduled, and although it is usually not rush work, time must be allowed for it on a percentage basis. For this reason, the total amount expected from the department must be carefully controlled. When construction work exceeds the predicted figure, it necessitates either overtime or the robbery of scheduled maintenance.

It is therefore the responsibility of all those concerned with the success of the maintenance program, and its contribution to the purpose of the plant, to determine in advance those needs of the plant which will be so accomplished and to interpret them in terms of man-hours available, in order that they may become a part of expectancies and not a serious detriment to the program.

General Maintenance

General maintenance is the sum of all the jobs which the department is called upon to do and expects to do, which do not categorically belong elsewhere. It is the duty of the department to perform routine upkeep of machinery, to make minor repairs where necessary, to perform minor construction where the investment in time and material does not warrant further classification, to do shop work of miscellaneous nature, and to accomplish virtually any type of job not meriting further attention or record.

This category is perhaps the most consistent and, of all, the most easily predicted from equipment history, and it is not likely to seriously interfere with the maintenance schedule. However, from the standpoint of good management it must be carefully watched and kept within reasonable limits, for it can get out of hand, and does in total represent a considerable investment. It is a place where proper management and allocation of time can plug leaks and represent considerable contribution to the success of the program.

Part II of this article, to appear soon in a following issue, tells you how to initiate a Retentive Maintenance Program for your plant. Completely illustrated with details of the forms suggested, it will help you set up your own system. Watch for it.

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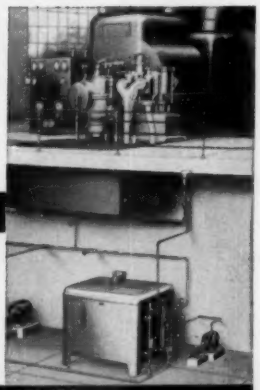

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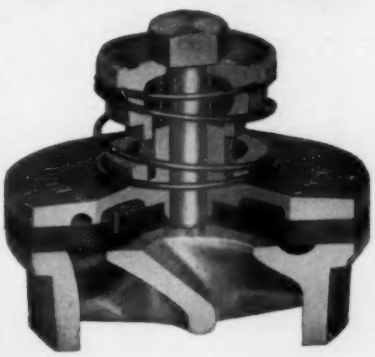

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Supervisor's Safety Manual. First Edition, 1956. 354 pages, 8¾ by 6, cloth. Prepared and published by the National Safety Council, 425 N. Michigan Ave., Chicago 11, Ill. Price $3.25.

This book is aimed directly at plant supervisors. By supervisor is meant anyone responsible for directing the work of others and so it covers all supervisory personnel from foreman to plant manager.

The National Safety Council in preparing this book realized the importance of the supervisor in promoting safe operations and arousing safety consciousness in the individual worker. As they say in the preface, on the supervisor largely depends the quality of job training, the development of right attitudes toward safety on the part of employees, and the detection of unsafe conditions and practices together with exercise of his influence in getting them corrected. It is he who can do much to build morale in a shop so that workers will try to improve their safety record.

The answer to this need is training of the supervisor in occupational safety and this book is intended to help in that training.

The book, which is very well illustrated, covers every aspect of normal plant operation. In addition to several chapters on the human element — that is, discussing the best ways in which the foremen and supervisors can influence the men working for them — there are chapters on health and first-aid, personal protective equipment, departmental housekeeping, materials handling and storage, guarding machines and equipment, hand and portable power tools, and fire prevention and control.

★ ★ ★

Legal Problems in Engineering, by Melvin Ford. Size 6 by 9; 391 pages including index; cloth binding. Published by John Wiley & Sons, Inc. 440 Fourth Ave., New York 16, N. Y. Price $7.50.

Written by an engineer who is also a practising lawyer, this book is designed for use and reference by engineers. It does not make the engineer independent of lawyers, but will help him avoid legal problems before they arise.

The book is broad in scope and deals with almost every legal subject that has any bearing on engineering. A special feature is its treatment of case material, which uses the cases to illustrate the discussion and point up legal problems that may be encountered in given circumstances. There is a minimum of legal jargon and the treatment is particularly valuable to the non-lawyer seeking a concise, reliable survey of the field.

ERNST

Boiler Accessories

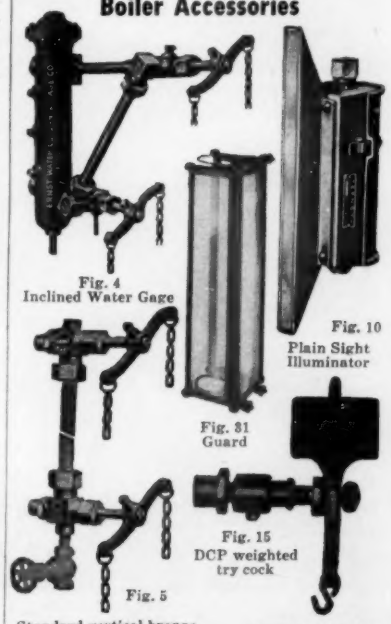

Fig. 4 Inclined Water Gage

Fig. 10 Plain Sight Illuminator

Fig. 31 Guard

Fig. 15 DCP weighted try cock

Fig. 5 Standard vertical bronze water gage, 350 pound

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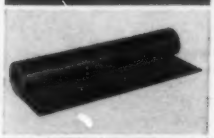
Gaskets and Tapes. Making gaskets and tapes from top quality Asbestos Wire Inserted Cloth is a Rhopac specialty. Specify Rhopac boiler gaskets, folded tapes (plain or tadpole), and retort door packing. Prompt service — low prices.



Sheet Gasket Materials. All standard gasket materials in various thicknesses kept in stock at all times — available in sheet or roll form. Your order will receive immediate attention.

Rhopac Packing Hooks. A packing extractor whose flexible shaft greatly simplifies the removing of old, worn-out packing. In set of 3 handy sizes — other sizes available. A great time and labor saver.

Mechanical Packings. We stock a wide selection of high temperature, high pressure and all standard types of packing. Special requirements are also developed and produced on short notice.

See Rhopac on All Gasket and Packing Problems

Exceptional Service — Top Quality

Rhopac, Inc.

3401 Cleveland Avenue, Skokie, Illinois

Manufacturers of mechanical packings, industrial and boiler gaskets, steel rule dies, flexible packing hooks

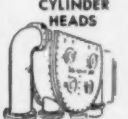
For more data circle 583 on Post Card

FOR HOT BOLTS USE Thred-Gard Anti-Seize Compound

Prevents Seizing and Galling of Threaded Surfaces to 1200°F.

FLANGED PIPE CONNECTIONS

CYLINDER HEADS



HANDHOLE AND FACE PLATES

Power and Utility Service: boiler manhole, handhole and face plate studs . . . cylinder head and exhaust manifold studs . . . flange bolts on high temperature pumps, valves and steam lines.

Refinery and Chemical Service: flange bolts on pipe connections, autoclaves, reactors, kettles, pumps and valves . . . studs on "cat" crackers, heat exchangers, suction heaters, coolers and condensers.

Steel Mill, Forge and Foundry Service: soaking pit or ingot stripper crane assemblies . . . steel studs in magnesium and aluminum dies and forging dies . . . studs on furnaces and cooking ovens.

Available in ½ pint, pint and quart cans. Order a trial can today!

Send for free sample and literature.

JOHN CRANE CRANE PACKING COMPANY

6429 Oakton Street, MORTON GROVE, ILL. (Chicago Suburb)
In Canada: Crane Packing Co., Ltd., Hamilton, Ont.
OFFICES IN ALL PRINCIPAL CITIES

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The feather-touch with
DYNAMITE ACTION!

MORE EFFECTIVE THAN EVER—MARLA AERO SPRAY PENETRATING OIL GIVES YOU THE ADVANTAGES OF:

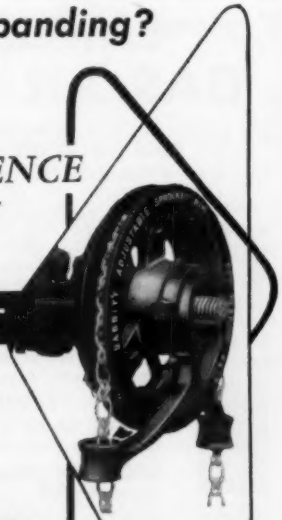
1. **SPRAY** — Assures penetration, with pressure, to the most hard to get at objects. Shoots a stream three feet if needed.
2. **SPEED** — Always ready at the touch of a button. The fastest acting non acid, non alkali penetrating oil known or money back.
3. **ECONOMICAL** — Spray container eliminates wasted surplus and time in application. Cannot leak or spill.
4. **HANDY** — Carried easily and is always ready for use. No chance for ingredients to weaken by exposure to air from a misplaced cap.
5. **VERSATILE** — Marla Spray Penetrating Oil is used to free the most corroded bolts, screws, pipe threads, bearings, bushings, pulleys, manifolds, valve guides, locks or any other stuck together metal parts.

INDUSTRIAL PACKAGING & PRICE SCHEDULE F.O.B. ST. LOUIS, MO.
Case of Six — 12-ounce Cans. . .$9.00 Case of Twelve — 12-ounce Cans. . .$17.40

ROTHLAN CORP. 3618 Laclede Ave. St. Louis 8, Mo.
Specialists in Fine Penetrating Oil for Over Thirty Years

For more data circle 585 on Post Card

Building or Expanding?
THINK of
SAFETY
CONVENIENCE
ECONOMY
THINK of
Babbitt



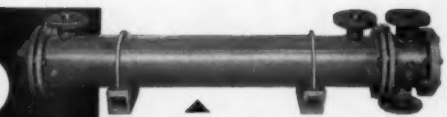
Adjustable
SPROCKET RIM
with Chain Guide

- Simplifies pipe layout
- Fits any size valve wheel
- Easy to install and operate
- Operates any valve from plant floor
- Time and money saving fixture
- No maintenance; first cost only cost
- Packed, completely assembled, one to a carton
- Hot galvanized, rust-proof chain available for all sizes
- Easy to follow instructions with each unit
- Your supplier carries complete stocks
- Write for new descriptive catalog sheet and prices

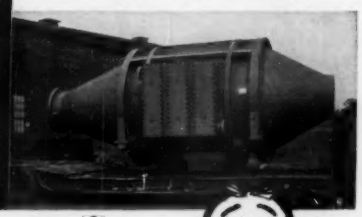
Babbitt STEAM SPECIALTY CO.
4 BABBITT SQUARE, NEW BEDFORD, MASS., U.S.A.

For more data circle 587 on Post Card

make
your headquarters
for **STANDARD**
or **SPECIAL**
HEAT
TRANSFER
UNITS



STANDARD SK Type "BD" Heat Exchanger, two-pass design for service in petroleum, power, chemical processing, and other industries. Also made in single-pass design.



SPECIAL SK Radiafin Air Cooler, one of two large coolers designed and manufactured for a special project. SK welcomes inquiries for special units—willingly offers experienced assistance.

Get Full Details. Write for Bulletin HT-1.

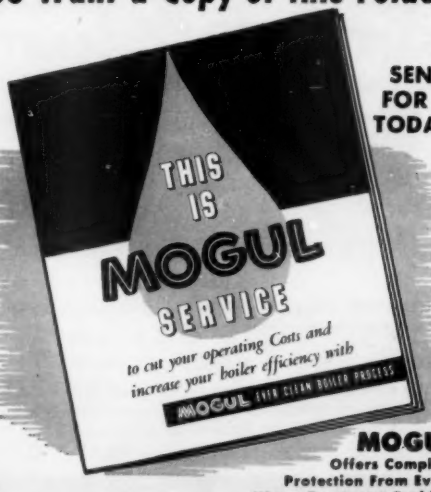
Schutte and Koerting
COMPANY
MANUFACTURING ENGINEERS
2221 STATE ROAD, CORNWELLS HEIGHTS, BUCKS COUNTY, PA.

Jet Apparatus: Ask for Condensed Bulletin J-1.	Rotameters & Flow Indicators: Ask for Condensed Bulletin 10-RA.	Valves: Ask for Condensed Bulletin V-1.	Heat Transfer Apparatus: Ask for Condensed Bulletin HT-1.	Gear Pumps: Ask for Bulletin 17-A.

For more data circle 586 on Post Card

WANT TO
CUT OPERATING COSTS . . .
INCREASE BOILER EFFICIENCY?
You Want a Copy of this Folder!

SEND FOR IT TODAY!


THIS IS
MOGUL
SERVICE
to cut your operating Costs and increase your boiler efficiency with
MOGUL EVER CLEAN BOILER PROCESS

MOGUL
Offers Complete Protection From Every Water Treatment Problem

The North American **MOGUL** Products Co.
Standard Building, Cleveland 11, Ohio
40 YEARS OF PROGRESS . . . AND STILL GROWING

For more data circle 588 on Post Card

MARLA

OPEN GEAR SPRAY LUBRICANT

USE ON ALL GEARS NOT RUNNING IN OIL

Absolutely Nothing Else Like It!

OUTLASTS ORDINARY LUBES 5-to-1

STICKS TO METAL

1. **ECONOMICAL**—Spray container reduces lubrication time. Long lasting film. One can covers approximately 25 sq. ft. of surface with no waste.
2. **HEAVY DUTY**—The finest extreme pressure adhesive lubricant there is for open gears.
3. **EASY-TO-USE**—No fuss . . . no muss. Ease of application encourages and assures complete lubrication of open gears.
4. **CLEAN**—No drip . . . no throw off . . . no clean up of excess lubricant. Will not drip in hot or steamy areas.
5. **SPRAY**—Assures perfect lubrication even to the most hard-to-get-at areas.
6. **HANDY**—Marla Spray Lubricant can be carried easily and is always ready for use. Eliminates the brush, paddle or any preheating.
7. **VERSATILE**—A superior lubricant also for cams, reciprocating actions, mono rails, guides, chains, sprockets and cables.

• PRICES F.O.B. YOUR PLANT

Case of Six — 12-ounce Cans **$10.74** Case of Twelve — 12-ounce Cans **$21.00**

Jobber Inquiries Invited

MANUFACTURED AND GUARANTEED BY

ROTHLAN CORP. • **3618 Laclede Avenue ST. LOUIS 8, MISSOURI**

For more data circle 589 on Post Card

NON CORROSIVE **SAFE TO USE** RUST RESISTANT

NON EXPLOSIVE **EASY TO HANDLE** GUM RETARDANT

KOR

pronounced "core"

—is a thorough sludge dispersant; and it also completely oxidizes all combustible deposits on convection surfaces, superheaters, air preheaters, water walls, economizers, breechings, and stacks.

KOR

—is processed to condition any grade residual oil; diesel oil; lubricating oil; gasoline; petroleum pitch and coal tar.

KOR

—will give the results you expect to get; and based upon actual results obtained it will cost far less than what you pay for ordinary brands of sludge solvents and "fire" side cleaners

• *WRITE FOR BULLETIN NO. 1515544* •

KOR CORPORATION

Division of Oxi Corporation

600 WEST 9th AVENUE, GARY, INDIANA

For more data circle 591 on Post Card

new

OXYGEN ANALYZER

Simplifies Flue Gas Analysis

- INSTANT READINGS— ACCURATE TO ± 0.5% O_2
- OPERATES ON FLASHLIGHT BATTERIES—NO CHEMICALS
- COMPLETELY PORTABLE AND SELF-CONTAINED

The new Model D2 Oxygen Analyzer offers speed, convenience, and versatility for industrial use in such applications as: Excess air measurements to improve combustion efficiency; monitoring air leakage in inert systems: insuring safe entry into mines, sewers, and vessels, etc.

OPERATION IS SIMPLE: Merely squeeze a bulb to draw sample gas into the unit, then press a switch and the oxygen content can be read directly and immediately!

RANGE: 0 - 25% O_2.
ACCURACY: ± 0.5% O_2.
WEIGHT: Only 3½ lbs.

For full details write to:

Arnold O. Beckman Inc.
1020 Mission Street
South Pasadena 5, California

For more data circle 590 on Post Card

CAMBRIDGE GAS ANALYZERS

at the
22nd NATIONAL POWER SHOW
BOOTHS 471–473

COMBINATION DISSOLVED OXYGEN AND DISSOLVED HYDROGEN ANALYZER, for continuously and simultaneously recording the oxygen dissolved in boiler feedwater and the hydrogen in steam condensate.

COMBINATION OXYGEN, CARBON-DIOXIDE, AND COMBUSTIBLES ANALYSER, for cement, lime, bauxite, sintering and other types of kilns.

CARBON DIOXIDE, HYDROGEN, CARBON MONOXIDE ANALYZER-RECORDER, for blast furnace top gases and for gas generator analysis.

HYDRAZINE ANALYSER, for Indicating and Recording N_2H_4 in boiler feedwater.

SULPHUR DIOXIDE ANALYZER, explosion proofed for hydroformer application; controllers for acid plants.

GAS ANALYZERS, single and multi-point for boiler flue gas.

PORTABLE pH METERS, for laboratory, plant and chemical processes.

SINGLE AND MULTI-POINT pH INDICATORS, RECORDERS AND CONTROLLERS.

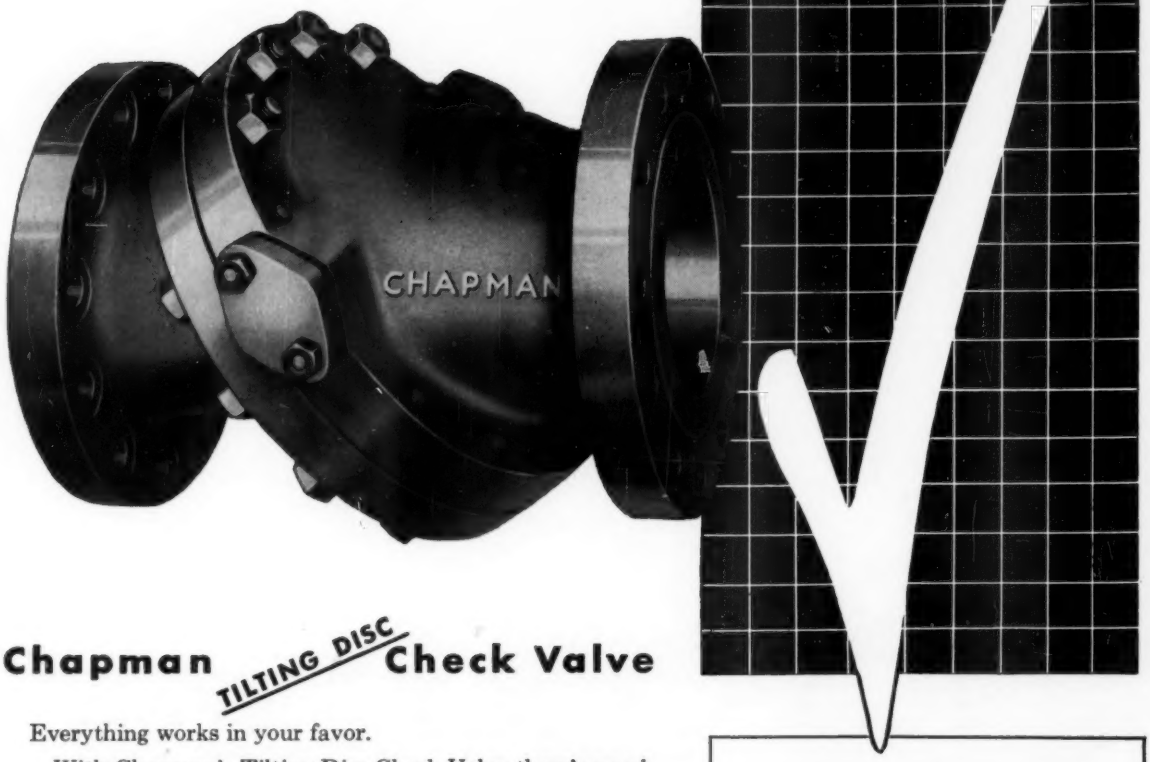
Visit us at Booths 471–473, or send for literature mentioning instrument in which interested.

CAMBRIDGE INSTRUMENT COMPANY, INC.
3523 Grand Central Terminal, New York 17, N. Y.

PIONEER MANUFACTURERS OF PRECISION INSTRUMENTS

For more data circle 592 on Post Card

Check This Check Valve
and keep your troubles in check



Chapman TILTING DISC Check Valve

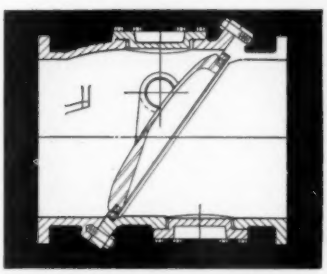
Everything works in your favor.

With Chapman's Tilting Disc Check Valve there's no vibration, no fluttering, no noise. There's no slamming, with usual piping arrangements, no banging to cause damage to system or valve. There's no grinding, scraping or wearing to either the disc or seat.

All of this means less headaches to you . . . both physical and financial headaches. The smooth, sure, quiet action means less, much less, maintenance over the longest period under toughest operating conditions.

Chapman Tilting Disc Check Valves with money-saving advantages like these are available in iron and steel, with standard end to end, for handling fluids or gases under a wide range of pressures. They're listed and shown in our Catalog 30-A. Send for it and check the valves you need for replacement or new piping systems, right now.

The CHAPMAN Valve Mfg. Co.
INDIAN ORCHARD, MASSACHUSETTS



The Valve That Goes with the Flow

Here's the idea in back of it all. When the flow is on, "airfoil" disc is held firmly against stops in the body. When the flow drops, disc balances itself quietly on whatever flow there is. When the flow stops, disc drops quickly and tightly on special bevel seat. It's as simple as that. It's as sound as that. And valve men will be pleased when they see that enough room is given around disc to cut down flow resistance.

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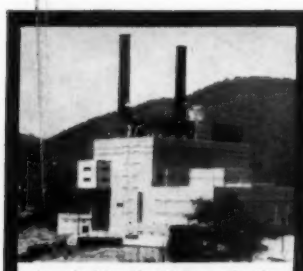
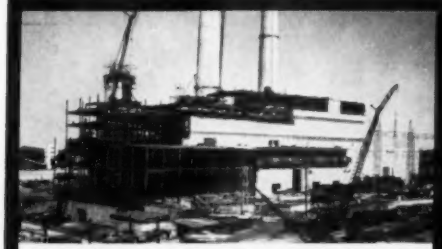


Appalachian Electric Power Co. Kanawha Riv. Plant, Glasgow, W. Va.

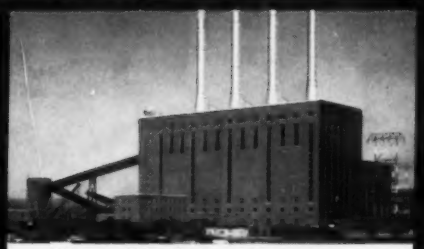
Florida Power & Light Company Cutler Power Plant, Miami, Fla.

Los Angeles Dept. Water & Power, San Fernando Valley Steam Plant

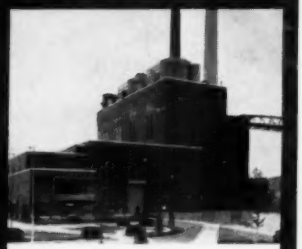
San Diego Gas & Electric Co. Encina Station, Carlsbad, Cal.



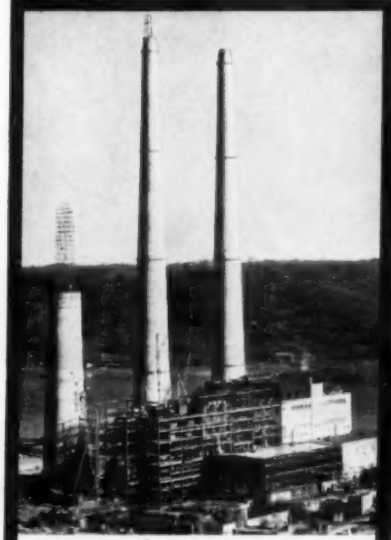
Ohio Valley Electric Corp., Kyger Creek Plant, Cheshire, Ohio (Power for AEC's Portsmouth area project.)



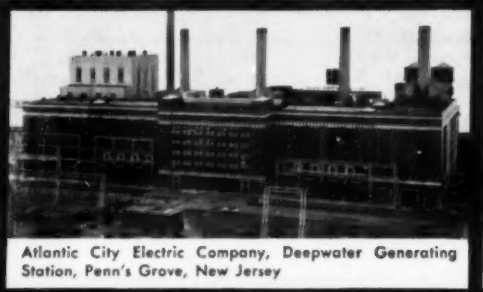
Niagara Mohawk Power Corporation Albany Steam Station, Albany, New York



Cincinnati Gas & Electric Co. Beckjord Sta., New Richmond, O.



Indiana-Kentucky Electric Corp., Clifty Creek Plant, Madison, Ind. (AEC Portsmouth project.)



Atlantic City Electric Company, Deepwater Generating Station, Penn's Grove, New Jersey

Metropolitan Edison Company Titus Station, Reading, Penna.

Gulf States Utilities Company, Baton Rouge, La. World's largest make-up demineralizers.

Illinois Power Company Hennepin Power Station, Illinois

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